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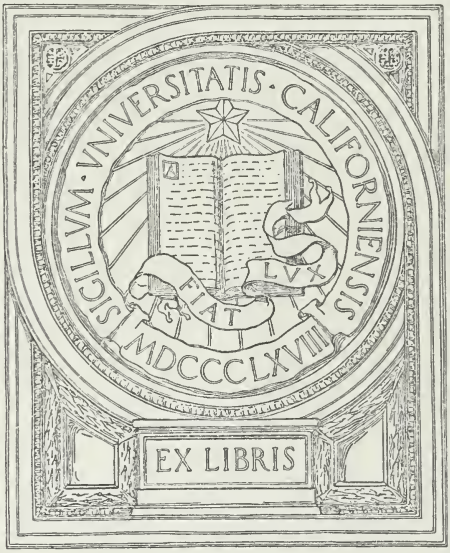
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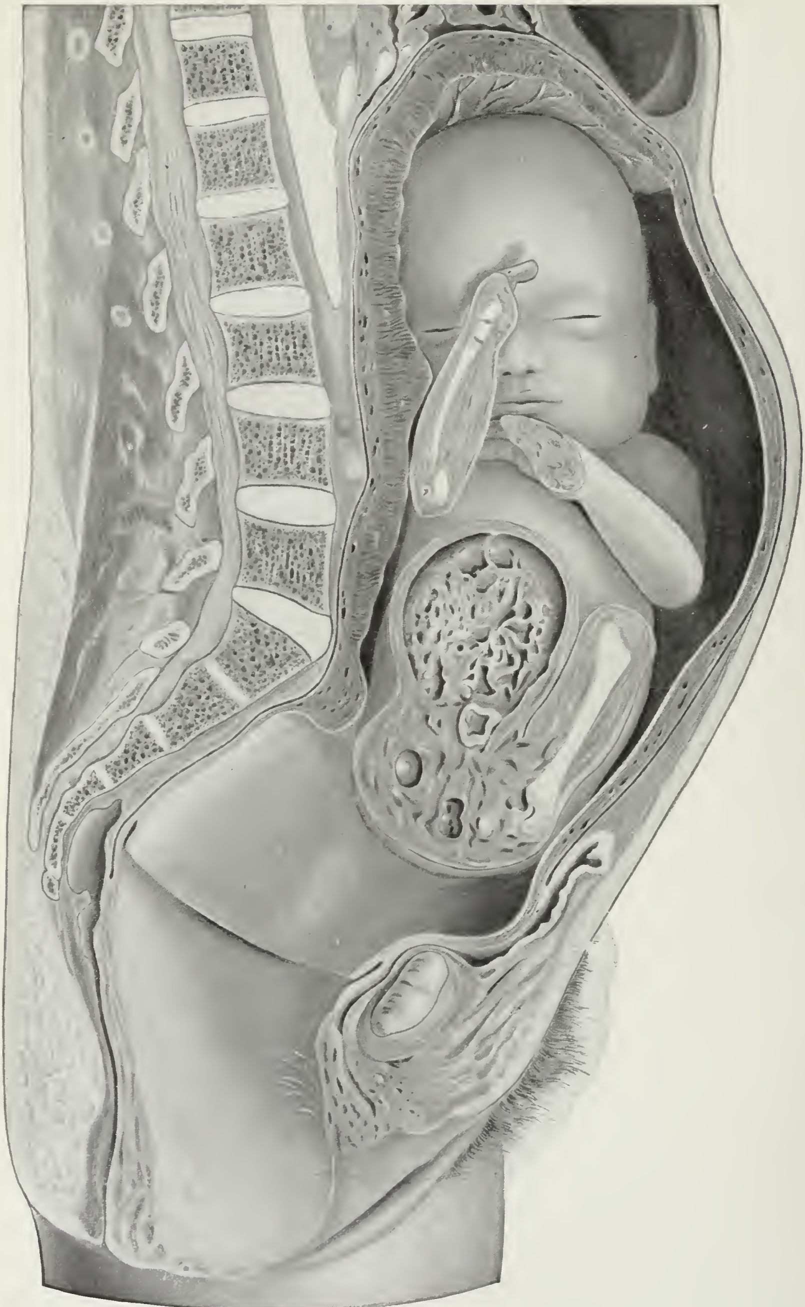

FROZEN SECTION THROUGH WOMAN DYING AT BEGINNING OF SECOND STAGE OF LABOR; BREECH PRESENTATION.

OBSTETRICS

A TEXTBOOK FOR THE USE OF STUDENTS AND PRACTITIONERS

BY

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SIXTH ENLARGED AND REVISED EDITION

WITH SEVENTEEN PLATES AND SEVEN HUNDRED AND THIRTY
ILLUSTRATIONS IN THE TEXT

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1930

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1920

PREFACE

The present edition has been so thoroughly revised that scarcely a page remains unchanged and many of the sections have been completely rewritten. Moreover, forty additional illustrations have been added and many of the old have been replaced by new ones, which it is hoped will add to the clarity of the text.

Although the work is an exposition of the science and art of obstetrics, as developed and practiced in the department of Obstetrics of the Johns Hopkins Hospital and University during the past thirty-six years, I have endeavored to give full credit to those in all parts of the world who have played a part in its development, as is evidenced by the relatively long lists of references at the end of each chapter. In this connection, I might state that the abbreviations of the titles of the various publications have been made to conform to those employed in the Index-Catalogue of the Library of the Surgeon General's Office.

In general, I have attempted to give an idea of the advances made in the anatomy, physiology, development and pathology of the organs concerned, as well as in the more practical aspects of the subject. Among the latter may be mentioned the employment of the anesthesia, the advantages and technic of the low cesarean section, the entire problem of the toxemias of pregnancy, and the benefits which have followed the more general employment of blood transfusion in many obstetrical emergencies.

As in the previous editions, I have endeavored to emphasize the conservative aspects of this branch of medicine, as is fitting in a work intended for the instruction of students and the guidance of practitioners, in the hope of counteracting to some extent the radical views so frequently expressed in current literature.

The publishers in their wisdom have decided to change the format of the book, which I hope will have the approval of its readers.

Finally, I desire to thank my associates—H. J. Stander and Charles H. Peckham—for valuable assistance, the former for aid in many chemical and metabolic questions, and the latter for the preparation of statistical data.

J. Whitridge Williams

25258

PREFACE TO THE FIRST EDITION

In the following pages I have attempted to set forth, as briefly as seemed to be consistent with thoroughness, the scientific basis for and the practical application of the obstetrical art.

Especial attention has been devoted to the normal and pathological anatomy of the generative tract. At the same time I have endeavored to present the more practical aspects of obstetrics in such a manner as to be of direct service to the obstetrician at the bedside.

No pains have been spared in illustrating the work, although mere artistic effect has necessarily often been sacrificed to accuracy and practical teaching qualities. With the exception of those relating to pure embryology, all illustrations representing microscopical sections have been drawn from my own specimens under my direct personal supervision, and are accurate reproductions of the originals. The drawings and diagrams illustrating labor and its mechanism for the most part represent the woman on her back, thus affording a closer correspondence with the actual conditions encountered in practice. The representations of the various operative procedures have been redrawn from photographs taken from life.

Although no attempt has been made to present a complete bibliography, I have endeavored to give at the end of each chapter such references to the early history, as well as to the most recent advances in each subject, as to enable the student to refer readily to the most important original sources. In order to insure accuracy, the individual articles have been consulted in every case.

In conclusion, I desire to express my appreciation of the excellent work of Miss Katherine M. Montague and Mr. F. S. Lockwood in the preparation of the illustrations and to thank my various assistants and my stenographer for most valuable aid. I am under very many obligations to my friend, Dr. Frank R. Smith, for the revision of the text and for many suggestions which have added materially to its clearness.

J. W. W.

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SECTION I

ANATOMY

CHAPTER I

THE PELVIS

Historical.—As the mechanism of labor is essentially a process of accommodation between the fœtus and the passage through which it must pass, it is apparent that obstetrics lacked a scientific foundation until the anatomy of the bony pelvis and of the soft parts connected with it was clearly understood.

We are indebted to Andreas Vesalius (1543) for the first accurate description of the pelvis. Prior to the publication of his observations it had generally been believed that the birth of the child could not be effected until the pelvic cavity had become increased in size by the separation and gaping of the pelvic bones. Vesalius demonstrated the fallacy of this conception, and showed that the pelvis, for practical purposes, should be considered as an unyielding bony ring. His work was further elaborated by his successor at the University of Padua, Realdus Columbus, who also demonstrated that each innominate bone was originally composed of three separate portions: the ilium, ischium, and pubis, which fused together just before the age of puberty. Julius Cæsar Arantius, Professor of Anatomy in Bologna (1559), also made important contributions to the subject, and was the first to recognize the existence of contracted pelvis.

That the teachings of these three great anatomists did not exert so great an influence as might have been expected was largely due to the fact that no less an authority than Ambroise Paré still continued to adhere to the doctrine of the separation of the pubic bones during labor, and promulgated it in his obstetrical writings.

Among obstetricians, Hendrick van Deventer was the first to make a thorough study of the anatomy of the pelvis. In his *New Light for Midwives* (1701) he dwelt upon it in detail, and also described the main varieties of contracted pelves. At that time he felt called upon to apologize for taking up what was apparently so useless a consideration.

Smellie was the first English authority to devote particular attention to the subject. In his work on midwifery, published in 1752, he gave an accurate description of the pelvis and its various measurements, and also introduced the method of determining the anteroposterior diameter which we still employ. A few years previously (1735), Johann Huwé had gone over somewhat the same ground, but his work did not receive anything like the consideration which was accorded to Smellie's investigations.

Almost simultaneously with Smellie, Levret, the great French obstetrician, published the results of his observations, and was one of the first to promulgate the conception of the axis and the planes of the pelvis. The value of his work, however, was considerably impaired by many inaccuracies. Among the Germans, Stein the younger was apparently the first to give a thoroughly accurate description of the pelvis, and since his time correct ideas upon the subject have gradually become popularized. Consequently, an attempt to follow the further development of our knowledge concerning the pelvis would practically resolve itself into writing a history of obstetrics. To do this would go far beyond the scope of the present work; and let it here suffice to say that among the more modern authors Naegele, Luschka, Michaelis, Litzmann, and Breus and Kolisko in Germany, and Hodge in this country deserve particular mention.

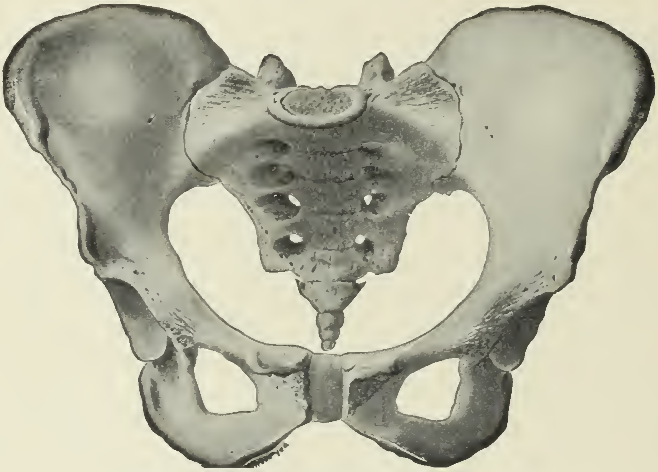

Fig. 1.—Normal Female Pelvis. × ⅓.

General Considerations.—In both sexes the pelvis forms the bony ring through which the body weight is transmitted to the lower extremities, but in the female it assumes a peculiar form which adapts it to the purposes of childbearing.

It is composed of four bones: the sacrum, the coccyx, and two innominate bones, the last two being united by strong articulations with the sacrum at the sacro-iliac synchondroses, and with one another at the symphysis pubis. The purely anatomical characteristics of the pelvis are dealt with at length in the standard works on anatomy, so that we shall limit our considerations to the peculiarities of the female pelvis which are of importance in childbearing.

The Pelvis from an Obstetrical Point of View.—The linea terminalis forms the boundary between the false and the true pelvis, the former lying above and the latter below it. The *false pelvis* is bounded posteriorly by the lumbar vertebræ and laterally by the iliac fossæ, while in front the boundary is formed by the lower portion of the anterior abdominal wall. It possesses no particular obstetrical significance, but serves to support the intestines in the nonpregnant woman, and the enlarged uterus in the pregnant condition. It varies considerably in size in different individuals, according to the flare of the iliac bones; but ordinarily in dried specimens the distances between the anterior superior spines of the ilium and between the most widely separated portions of the iliac crests measure 23 and 26 centimeters, respectively.

The *true pelvis* lies beneath the linea terminalis, and is the portion concerned in childbearing. It is bounded above by the promontory and alæ of the sacrum, the linea terminalis, and the upper margins of the pubic bones, and below by the pelvic outlet. Its cavity, roughly speaking, may be compared to an obliquely truncated cylinder with its greatest height posteriorly, since its anterior wall at the symphysis pubis measures 4.5 to 5 centimeters, and its posterior wall 10 centimeters. With the woman in the upright position, the upper portion of the pelvic canal is directed downward and backward, while in its lower course it curves and becomes directed downward and forward.

The walls of the true pelvis are partly bony and partly ligamentous. Its posterior boundary is furnished by the anterior surface of the sacrum, its lateral limits are formed by the inner surface of the ischial bones and by the sacrosciatic notches and ligaments; while in front it is bounded by the obturator foramina, the pubic bones, and the ascending rami of the ischial bones.

The only part of the lateral wall of the pelvis which is entirely bony is made up of the body of the ischium and part of the ilium, the inner surface of which, with the woman in the upright position, forms an inclined plane which is directed from above downward and inward, and from behind forward. These surfaces were designated as the *inclined planes* of the pelvis by Hodge, who taught that they exercised considerable influence in causing internal rotation of the head during labor. This view, however, has since been abandoned. If the planes of the ischial bones were extended downward they would meet somewhere about the region of the knee. Extending from the middle of the posterior margin of each ischium are the ischial spines, which are of no little obstetrical importance, inasmuch as a line drawn between them represents the shortest diameter of the pelvic cavity. Moreover, since they can be readily felt on vaginal examination, they serve as valuable landmarks in determining the extent to which the presenting part has descended into the pelvis.

The sacrum forms the posterior wall of the pelvic cavity. Its upper anterior margin, corresponding to the body of the first sacral vertebra, and designated as the promontory, can be felt on vaginal examination, and offers a landmark which serves as the basis of internal pelvimetry. Normally, the sacrum presents a marked vertical and a less pronounced lateral concavity, which, in abnormal pelves, may undergo important variations. A straight line drawn from the promontory to the tip of the sacrum usually measures 10 centimeters, whereas if the concavity be followed the distance averages 12 centimeters. The sacrum was formerly regarded as the "keystone" of the pelvic arch, but Matthews Duncan showed that this conception was erroneous, and that it represents an inverted keystone, inasmuch as it is wider along its anterior than along its posterior surface, so that it would tend to slip downward and forward into the pelvic cavity under the influence of the body weight were it not held in position by the strong posterior iliosacral ligaments (Fig. 2).

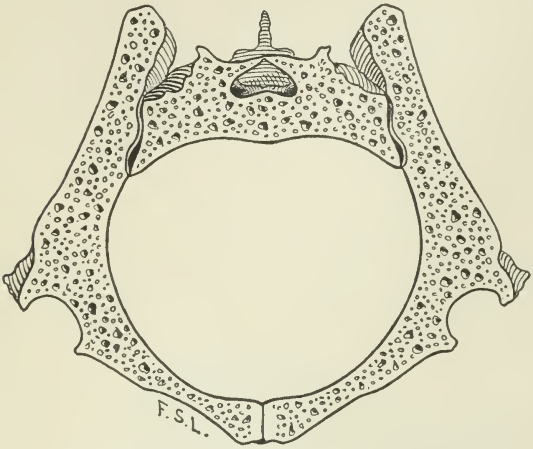

Fig. 2.—Drawing Showing that the Sacrum is not the Keystone of the Arch.
Modified from Duncan. × ⅓.

In the female the pubic arch presents a characteristic appearance. The descending rami of the pubic bones unite at an angle of 90 to 100 degrees, and form a rounded opening through which the head can readily pass. Its margins are more delicate than in the male, and are considerably everted.

Planes and Diameters of the Pelvis.—Owing to the peculiar shape of the pelvic cavity and the difficulty experienced in rendering clear the exact location of a body occupying it, for greater convenience in description it is customary to construct certain imaginary planes through it. Those most frequently employed are designated as (1) the superior strait; (2) the inferior strait; (3) the plane of greatest, and (4) the plane of least, pelvic dimensions (Figs. 3 and 5).

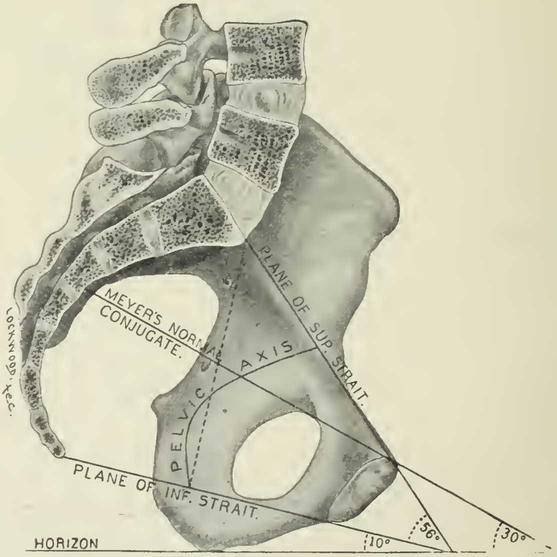

Fig. 3.—Sagittal Section through Normal Pelvis. × ⅓.

The superior strait represents the upper boundary of the cavity, and is frequently spoken of as the pelvic inlet. It is somewhat oval in shape, with a depression on its posterior border corresponding to the promontory of the sacrum, and is sometimes described as blunt heart-shaped. It is bounded posteriorly by the promontory and alæ of the sacrum; laterally by the linea terminalis; anteriorly by the horizontal rami of the pubic bones and the upper margin of the symphysis pubis. Strictly speaking, it is not a mathematical plane, since its lateral margins, as represented by the linea terminalis, are at a lower level than its central portion between the promontory and symphysis.

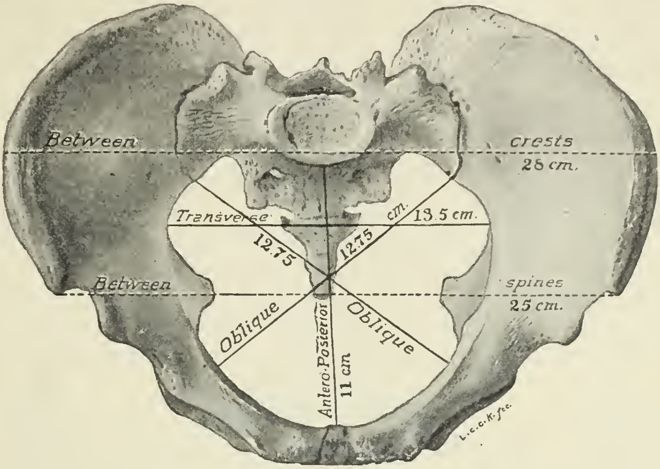
Between
crests
28 cm.
Transverse
cm.
13.5 cm.
12.75
12.75
Between
spines
25 cm.
Oblique
Antero-Posterior
11 cm
Oblique
L.C.C.K. fec.

Fig. 4.—Normal Female Pelvis Showing Diameters of the Superior Strait. × ⅓.

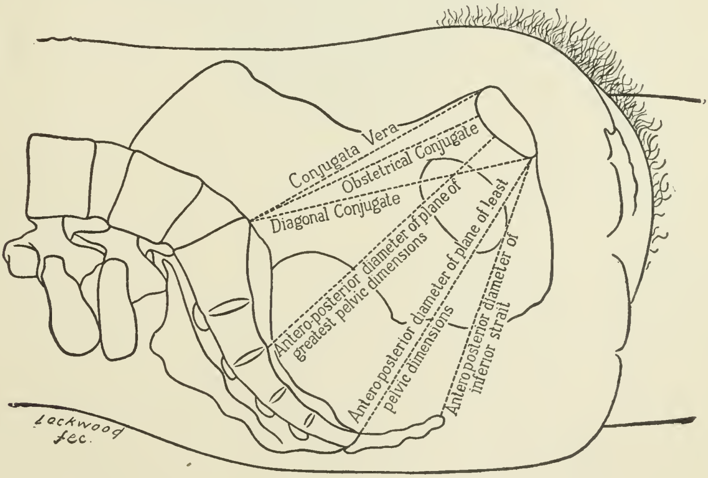
Conjugata Vera
Obstetrical Conjugate
Diagonal Conjugate
Antero-posterior diameter of plane of greatest pelvic dimensions
Anteroposterior diameter of plane of least pelvic dimensions
Antero-posterior diameter of inferior strait
Lockwood fec.

Fig. 5.—Diagram Showing Pelvic Planes. × ⅓.

Four diameters are usually described as traversing the superior strait: the anteroposterior, the transverse, and two oblique diameters. The anteroposterior diameter extends from the middle of the promontory of the sacrum to the upper margin of the symphysis pubis, and is designated as the *conjugata vera* or *true conjugate*. This term was first employed by Roederer, who likened the superior strait to an ellipse, whose shorter diameter ran anteroposteriorly. Normally the conjugata vera measures 11 centimeters, but it may become markedly shortened in abnormal pelves. From a practical point of view it is the most important diameter, inasmuch as it is the point of departure for all attempts to estimate the size of the pelvis in actual practice. The transverse diameter is constructed at right angles to the conjugata vera, and represents the greatest distance between the linea terminalis on either side; it usually intersects the conjugata vera at a point a short distance in front of the promontory. Normally it measures 13.5 centimeters. Each of the oblique diameters extends from one of the sacro-iliac synchondroses to the iliopectineal eminence on the opposite side of the pelvis. They measure 12.75 centimeters, and are designated as right and left respectively, according as the starting-point is the right or left sacro-iliac synchondrosis. Instead of employing these terms, the Germans usually speak of the first and second oblique diameters, respectively. The sacrocotyloid diameters are sometimes described; they extend from the middle of the promontory of the sacrum to the iliopectineal eminence on either side, and measure from 8.75 to 9 centimeters. Normally these two diameters are of equal length, but in certain forms of contracted pelvis they may present marked variations.

The anteroposterior diameter of the superior strait, or conjugata vera, is also designated as the *anatomical conjugate*. This does not represent the shortest distance between the promontory of the sacrum and symphysis pubis, which is along a line drawn from the former to a point on the inner surface of the symphysis a few millimeters below its upper margin. The latter is the shortest diameter through which the head must pass in descending into the superior strait, and was designated by Michaelis as the *obstetrical conjugate*. It is a few millimeters shorter than the anatomical or true conjugate, but for practical purposes the distinction is rarely made, and the obstetrician simply speaks of the conjugata vera.

Unfortunately, in the living woman, the conjugata vera cannot be measured directly with the examining finger, and various more or less complicated instruments have been devised for its determination, none of which gives perfectly satisfactory results. For clinical purposes, therefore, we are content to estimate its length indirectly, by measuring the distance from the lower margin of the symphysis to the promontory of the sacrum, and subtracting from the result 1.5 to 2 centimeters, according to the height and inclination of the symphysis pubis. This diameter is the *conjugata diagonalis* or *oblique conjugate*, the importance of which was first emphasized by Smellie.

The outlet of the pelvis is designated the inferior strait. It is not a plane in a mathematical sense, but consists of two triangular planes whose bases would meet on a line drawn between the two ischial tuberosities. It is bounded posteriorly by the tip of the coccyx, laterally by the greater sacrosciatic ligaments and the ischial tuberosities, and anteriorly by the lower margin of the pubic arch (Fig. 6). For the pelvic outlet two diameters are described: the anteroposterior and the transverse. The former extends from the lower margin of the symphysis pubis to the tip of the coccyx, and the latter between the inner margins of the ischial tuberosities. With the coccyx in its usual position, the anteroposterior diameter measures 9.5 centimeters, which is increased to 11.5 centimeters during labor by the backward displacement of the tip of the coccyx. The transverse diameter measures 11 centimeters.

The plane of greatest pelvic dimensions was first described by Levret, and, as its name implies, represents the roomiest portion of the pelvic cavity. It extends from the middle of the posterior surface of the symphysis pubis to the junction of the second and third sacral vertebræ, and laterally passes through the ischial bones over the middle of the acetabulum. Its anteroposterior and transverse diameters measure 12.75 and 12.5 centimeters, respectively. Since its oblique diameters terminate in the obturator foramina and the sacrosciatic notches, their length is indeterminate.

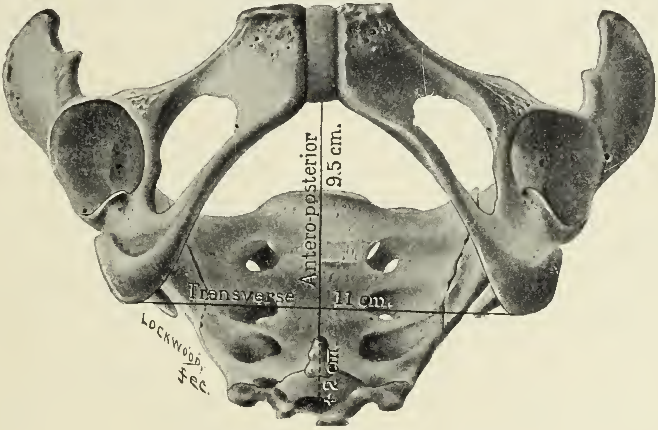

Fig. 6.—Pelvic Outlet. × ⅓.

The plane of least pelvic dimensions extends through the lower margin of the symphysis pubis, the tip of the sacrum, and the ischial spines. Its anteroposterior diameter measures 11.5 centimeters. Its transverse diameter extends between the ischial spines and measures 10.5 centimeters, being the shortest diameter in the normal pelvic cavity.

In order to facilitate the study of the pelvic cavity, Hodge constructed four parallel planes, the first of which is the superior strait; while the other three are parallel to it and pass through the lower margin of the symphysis pubis, the ischial spines, and the tip of the coccyx, respectively. The second parallel practically corresponds to the plane of greatest pelvic dimensions, and is very closely related to that described by Veit as the main plane of the pelvis, which extends from the lower margin of the symphysis pubis to the junction of the first and second sacral vertebræ. According to Veit this, from an obstetrical standpoint, is the largest plane of the pelvis, inasmuch as it is not encroached upon by the pelvic soft parts, but passes above the obturator and pyriformis and below the iliopsoas muscles.

Most pelves present slight individual variations in size, and perfectly normal and symmetrical examples are rarely seen. The measurements which we have given are those of Schroeder, and are the averages obtained from the accurate mensuration of 50 normal pelves.

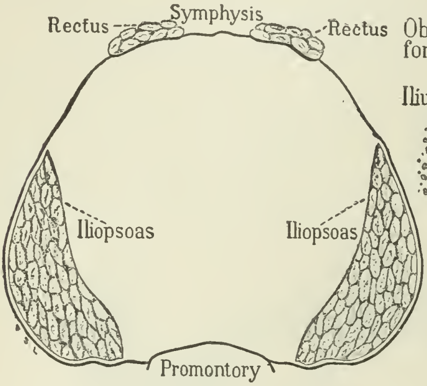
Rectus
Symphysis
Rectus
Iliopsoas
Iliopsoas
Promontory

Fig. 7.—Superior Strait (Veit).

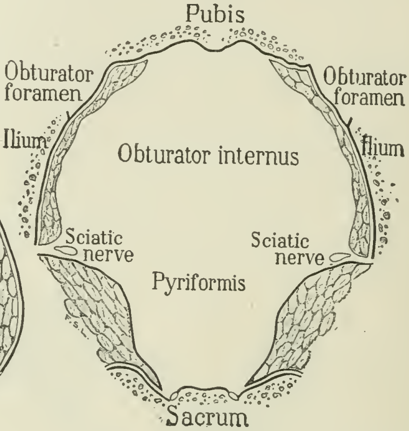
Pubis
Obturator foramen
Obturator foramen
Ilium
Ilium
Obturator internus
Sciatic nerve
Sciatic nerve
Pyriformis
Sacrum

Fig. 8.—Plane of Greatest Dimensions.

Pelvic Inclination.—The normal position of the pelvis, with the woman in the erect posture, can be reproduced by holding the specimen in such a way that the incisions of the acetabula look directly downward. According to Meyer, the same result is obtained when the anterior superior spines of the ilium and the pubic spines are placed in the same vertical plane. Under these conditions the promontory of the sacrum is 9.5 to 10 centimeters higher than the upper margin of the symphysis pubis.

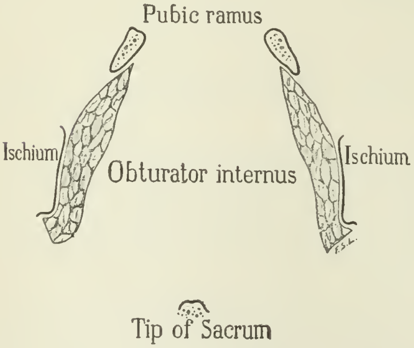
Pubic ramus
Ischium
Obturator internus
Ischium
Tip of Sacrum

Fig. 9.—Plane of Least Dimensions (Veit).

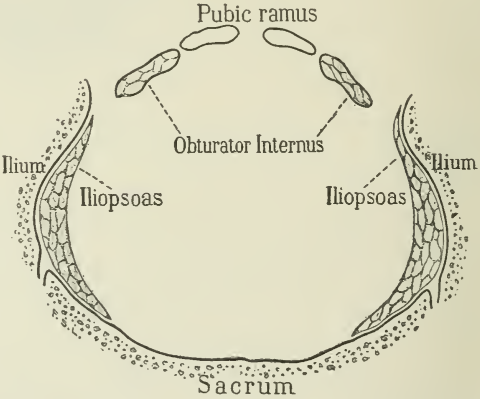
Pubic ramus
Obturator Internus
Ilium
Iliopsoas
Iliopsoas
Ilium
Sacrum

Fig. 10.—Veit's Main Plane.

By the term *pelvic inclination* is understood the angle which the plane of the superior strait forms with the horizon (see Fig. 3). This conception was first introduced by J. J. Müller, and Roederer, and the early statements concerning it were very conflicting. According to Meyer, the center of gravity of the body passes along an imaginary vertical plane just posterior to the acetabula, so that under the influence of the body weight the pelvis would tend to rotate backward, were it not held in position by the strong iliofemoral ligaments. It is therefore apparent that the pelvic inclination must vary according to the degree of tension of these structures; it will be diminished when they are relaxed, and *vice versa*. It is least marked when the legs are slightly rotated inward and spread a little apart, and greatly increased when the knees are pressed tightly together, or when the legs are widely spread apart or rotated strongly either inward or outward. With the woman in the upright position the pelvic inclination is usually estimated at 45 to 50 degrees, but may vary from 40 to 100 degrees, according to the degree of tension exerted by the iliofemoral ligaments. In certain diseased conditions it may be obliterated, when the plane of the superior strait may become parallel to, or even form an obtuse angle with, the horizon.

The first accurate work upon this subject was done by Naegele, who measured the distance from the floor to the lower margin of the symphysis pubis and to the tip of the sacrum, respectively, and in this way estimated the inclination which the inferior strait formed with the horizon. He then placed a normal pelvis in a similar position and estimated the inclination of its superior strait, which was usually about 60 degrees.

In view of the variations to which the pelvic inclination is subject, Meyer introduced a new conception concerning it, and showed that it was considerably influenced by the extent to which the sacrum rotated about its transverse axis. As the latter passes through the center of the body of the third sacral vertebra, it is apparent that this portion of the sacrum retains approximately the same position, no matter to what extent its upper or lower portions may be displaced. Meyer, therefore, constructed a diameter extending from the upper margin of the symphysis to the middle of the third sacral vertebra, and designated it the *normal conjugate*. Its inclination, as he estimated it, was 30 degrees, and he stated that, as a usual thing, it was practically constant in all positions of the body.

Except when markedly abnormal, the pelvic inclination possesses no practical obstetrical significance, and is of value only in the study of atypical pelves and in anthropology. Several complicated instruments have been invented for determining it. In 1900, Neumann and Ehrenfest pointed out that for practical purposes the degree of pelvic inclination corresponds to the inclination of the external conjugate, and devised a comparatively simple instrument for determining it.

Since the lower margin of the symphysis occupies a lower level than the tip of the sacrum, the plane of the inferior strait is also inclined to the horizon, forming an acute angle, which is usually estimated at 10 degrees. Much more important, however, is the angle which is formed between the posterior surface of the symphysis pubis and the conjugata vera; this is usually estimated at 90 to 100 degrees, but varies considerably according to the shape, height, and inclination of the former. This must always be taken into consideration in estimating the length of the conjugata vera from that of the conjugata diagonalis, since it is evident that the amount to be substracted from the latter will vary with the size of the angle in question.

The Pelvic Axis.—Deventer, in 1701, introduced the conception of a pelvic axis. Since then numerous methods for its construction have been described, the most usual being a line drawn through the centers of innumerable planes extending from the symphysis to the sacrum, thus giving a graceful curve (see Fig. 3). This was formerly believed to represent the course which the child pursued in its passage through the pelvis, but the work of Naegele, Hegar, Pinard, and others has shown that such is not the case, and that an axis so constructed possesses only a historical interest.

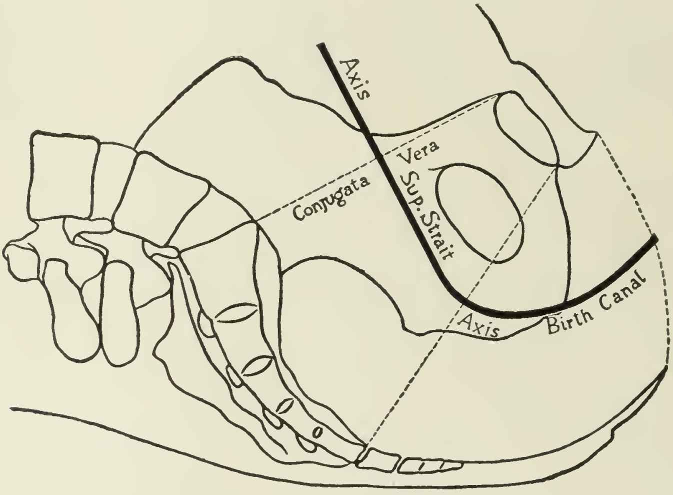

Fig. 11.—Diagram Showing Pelvic Axis. × ⅓.

At the end of pregnancy the axis of the superior strait, if extended directly upward, would pass through the abdominal wall at about the region of the umbilicus, while the axis of the inferior strait would impinge upon the promontory of the sacrum. As the pelvic canal is practically cylindrical in shape down to the plane of greatest pelvic dimensions, it is apparent that the head must descend along the downward prolongation of the axis of the superior strait until it has nearly reached the level of the ischial spines, and only begins to curve forward in the region of the inferior strait. Therefore the obstetrical pelvic axis should be represented as straight in its upper and curved only in its lower portion (see Fig. 11), as was well understood by Hodge, and strongly insisted upon by Sellheim.

The Pelvic Joints.—Anteriorly the pelvic bones are held together by the symphysis pubis, which consists of a mass of fibrocartilage, and by the superior and inferior pubic ligaments, the latter being frequently designated as the ligamentum arcuatum pubis. Luschka demonstrated the presence of a synovial cavity in the fibrocartilage, and therefore classed the symphysis among the true joints (Fig. 12). Joessel, and Loeschke, on the other hand, deny its existence, and state that the fluid in the interior of the symphysis is simply a product of degeneration. Whether it be a true joint or not, in any case the symphysis admits of a certain amount of motility, which becomes more marked during pregnancy, particularly in multiparous women. This fact was demonstrated by Budin, who showed that if the finger were inserted into the vagina of a pregnant woman, and she were made to walk, one could distinctly feel the ends of the pubic bones move up and down with each step.

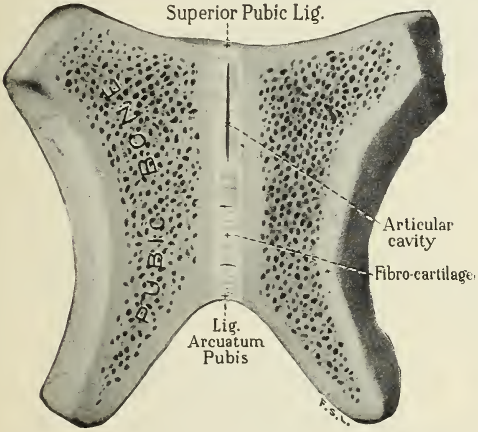

Fig. 12.—Frontal Section Symphysis Pubis (Spalteholz). × 1.

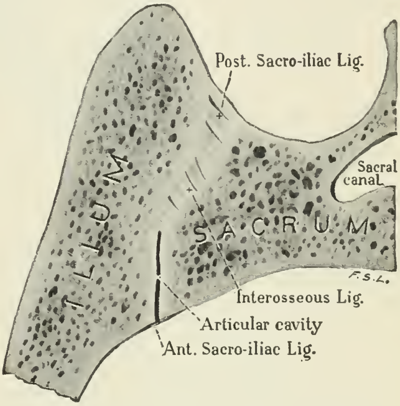

Fig. 13.—Sacro-iliac Synchondrosis (Spalteholz). × 1.

The articulations between the sacrum and innominate bones were formerly described as synchondroses, but Luschka conclusively demonstrated the presence of a synovial cavity within them, and therefore classed them among the true joints (Fig. 13). These articulations possess a certain amount of motility, which plays a not unimportant part in practical obstetrics.

Walcher, in 1889, redirected attention to the variation in size of different portions of the pelvic canal resulting from changes in the relation between the thighs and the pelvis, and stated that the diagonal conjugate varied about 1 centimeter in length, according as it was measured with the woman in the usual obstetrical position, or with her buttocks resting on the edge of the table and her legs hanging down without any support. This has since been known as the Walcher or hanging position, and is utilized in dealing with contracted pelves; and occasionally the increase in the size of the conjugata vera brought about by it has proved sufficient to permit the engagement of the presenting part, which otherwise could not occur. Küttner, in 1898, showed in three cases that the conjugata vera was respectively 1.4, 0.9, and 1 centimeter longer when measured in the hanging than in the lithotomy position. Figure 14 gives a graphic illustration of the changes in shape in one of the pelves, which he studied.

Furthermore, rotation of the innominate bones upon the sacrum causes changes in the anteroposterior diameter of the inferior strait. In the Walcher position it is shortened, whereas it is lengthened when the legs are sharply flexed over the body. In 1911, I showed that it could also be increased by from 1 to 2.5 centimeters by placing the woman in an exaggerated Sims position.

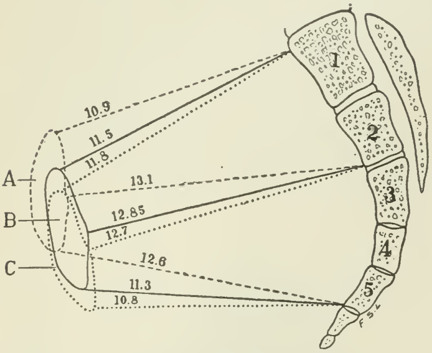

Fig. 14.—Diagram Showing Variation of Anteroposterior Diameter of Pelvis in Various Positions (Küttner). × ⅕.
A, lithotomy; *B.* horizontal; *C,* Walcher's position.

Methods of Comparing Pelves.—Inasmuch as the normal pelvis usually presents slight individual variations in its form and dimensions, and as contracted pelves differ markedly from one another in shape, several devices have been employed to enable us readily to compare their points of difference. The decimal method, suggested by Litzmann, is very satisfactory for most purposes. In it the various diameters are expressed in terms of the conjugata vera, which is reckoned as 100.

Comparison of Various Diameters of Normal Pelves by Litzmann's Decimal Method	Diameters		
	Antero-posterior	Transverse	Oblique
Superior strait	100.0	122.7	113.0
Plane of greatest pelvic dimension	115.0	113.6	....
Plane of least pelvic dimension	105.5	95.5	....
Inferior strait	105.5	100.0	....

Breisky introduced a graphic method for comparing pelves and constructed three diagrams, representing a vertical mesial section of the pelvis, the plane of the superior strait, and a frontal view of the pelvis. The first is constructed upon Meyer's normal conjugata, the second upon the distance between the sacroiliac synchondroses, and the third upon the transverse diameter of the pelvic outlet, but they are now little used.

Individual Variations in the Pelvis.—With the exception of the skull, no portion of the skeleton presents greater individual variations than the pelvis. This is due partly to the fact that it is developed from a considerable number of bones, and partly to the varying mechanical and developmental influences to which it is subjected during the early years of life. Indeed, we may say that no two pelves are exactly alike, and that perfectly normal pelves are rarely seen; so that an accurate conception of the form and dimensions of what may be termed the normal type can be obtained only from averages based upon the examination of numerous approximately normal pelves.

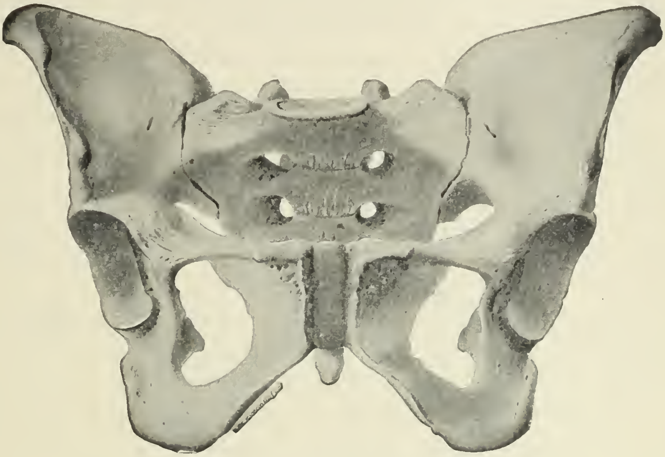

Fig. 15.—Front View Female Pelvis. × ⅓.

Owing to the greater employment of the right half of the body, the corresponding side of the pelvis is more developed than the left. Individual variations may be observed in the form, consistence, and general character of the pelvic bones, in the angles which the iliac fossæ form with the walls of the pelvic basin, in the shape of the sacrum, and particularly in that of the cavity itself. In view of the varying thickness of the pelvic bones, and especially of the degree

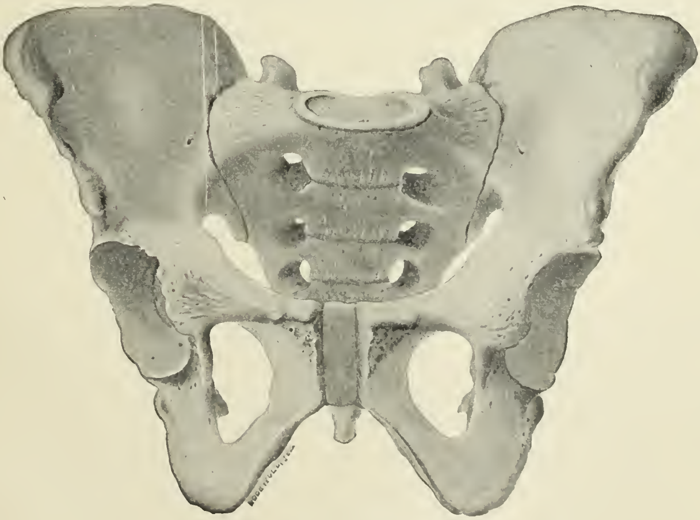

Fig. 16.—Front View Male Pelvis. × ⅓.

of flaring of the ilia, accurate conclusions cannot be drawn from external pelvimetry alone.

Sexual Differences in the Adult Pelvis.—The pelvis presents marked sexual differences. Speaking generally, we may say that in the male the pelvis is heavier, higher, less graceful, and presents a more conical appearance than in the female. In the former the muscular attachments are much more strongly marked, and the iliac bones are less flared than in the latter. The pubic arch is more angular in shape, and presents an aperture of 70 to 75 degrees, as compared to 90 to 100 degrees in the female. This difference is so marked that one usually speaks of the pubic angle in the male and the pubic arch in the female. In the male pelvis the superior strait is smaller and more triangular in outline, while the pelvic cavity is deeper and more conical in shape. These differences are readily noted in Figures 15, 16 and 17, and may be especially emphasized by a comparison of the various measurements in the two sexes.

Broadly speaking, the external measurements are practically alike in both sexes, though the distance between the anterior superior spines of the ilium is somewhat less in the male; while all the diameters of the pelvic cavity are shorter, as is shown by the table below. Indeed, the outlet of the male type of pelvis is contracted to such a degree as to render very difficult the passage of a living child under the pubic angle. Occasionally the female pelvis may approach the male type, and such funnel pelves may offer insuperable obstacles to the birth of the child, and necessitate radical operative procedures to effect delivery.

Comparison of Male and Female Pelvis	Diameters in Centimeters		
	Antero-posterior	Transverse	Oblique
Superior strait:			
Male	10.5	12.5	12.00
Female	11.0	13.5	12.75
Inferior strait:			
Male	9.5	8.0	....
Female	11.5	11.0	....

Numerous not very satisfactory attempts have been made to explain the cause of the differences between the male and female pelvis. According to Fehling and most subsequent investigators, sexual differences make their appearance as early as the fourth or fifth month of intrauterine life, so that the sex can be ascertained long before term by examination of the pelvis. Arthur Thompson has made the same statement, and my own investigations have led me to similar conclusions. On the other hand, Schroeder and other authorities attributed the characteristic shape of the female pelvis to the presence of the internal genitalia, and stated that the pelves of female eunuchs, as well as those of individuals in whom the uterus is congenitally absent, conform to the male type. While the correctness of such statements cannot be doubted, it nevertheless seems probable that the greater part of the sexual differences must be due to inherent developmental and hereditary factors.

Racial Differences in Pelves.—Considerable variations may be observed in the form of the pelvis in various races, and especially upon comparing those obtained from aboriginal and civilized peoples. But in spite of the researches of Weber, Stein, Verneau, Topinard, Turner, and others, our knowledge of the subject is still fragmentary. Stein distinguished four groups of pelves:

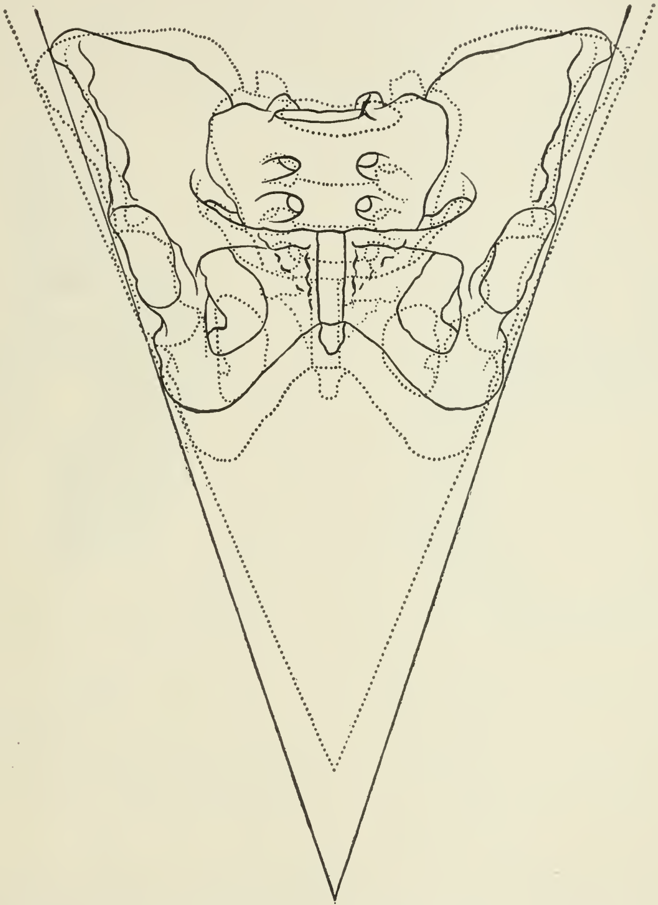

Fig. 17.—Diagram Showing Difference in Shape of Male [. . .] and Female [——] Pelvis.

1. Blunt heart-shaped
2. Elliptical, with the greatest diameter transverse
3. Round
4. Elliptical, with the greatest diameter anteroposterior

Topinard attempted to classify pelves according to their "general index"—that is, the relation between their height and width, as represented by the distance between the iliac crests. His careful measurements showed that the pelvis becomes increasingly lower and broader the more civilized the race from which it is obtained.

Turner based his classification upon the relation between the transverse and anteroposterior diameters of the superior strait, and divided pelves into three great groups: dolichopellic, in which the conjugata vera is greater than the transverse diameter; mesatipellic, in which the conjugata vera and transverse diameters are of equal length; and platypellic, in which the conjugata vera is shorter than the transverse diameter. He stated that the first variety had not been observed in women, though it is not infrequent in men; but the investigations of Scharlau show that Turner was in error, as it is frequently noted in the aboriginal women of Australia. The mesatipellic variety is observed in the women of the lower races, notably among the Bushmen, Hottentots, and the lower classes of Negroes; while the platypellic forms are found in all the higher races. But even among civilized whites considerable racial differences are frequently noted, and it is generally stated that the pelves of the English and Holstein women are broader than those of other nationalities; while the Jewesses living in the vicinity of Dorpat have extremely small pelves. Gache states that the pelvis is usually normal in the Argentine Republic, while it is imperfectly developed and frequently funnel-shaped in Mexico.

While the study of the racial differences in the pelvis presents a marked anthropological interest, it is, as yet, of little practical obstetrical value, as no extended studies have been made concerning the form and size of the heads of children which are born through them. The careful work of my former assistant, T. F. Riggs, has shown that contracted pelves occur several times more frequently among black than white women in Baltimore, while operative delivery is more frequently required among the latter. This is due to the fact that the Negro children are somewhat smaller and have more compressible heads, and thus compensate for the smaller size of the pelvis. Acosta-Sison makes a similar statement concerning the Philippine women, and Kinoshita of Tokio informed me that in Japan both the pelvic and cephalic measurements fall below the average observed in European and American white women.

Pelvis of the New-born Child.—The pelvis of the child at birth is partly bony and partly cartilaginous. The innominate bone does not exist as such, its place being taken by the ilium, ischium, and pubis, which are united by a large Y-shaped cartilage, the three bones meeting in the acetabulum. The iliac crests and the acetabula, as well as the greater part of the ischiopubic rami, are entirely cartilaginous in structure. Figures 18 and 19 clearly show the extent to which the infantile pelvis is ossified.

The cartilaginous portions of the pelvis gradually give place to bone, but complete union in the neighborhood of the acetabulum does not occur until about the age of puberty, and occasionally even at a later period. Indeed, we may say that the innominate bones do not become completely ossified and fully developed until between the twentieth and twenty-fifth years.

Each innominate bone is developed from 12 centers of ossification. Three of these are primary and give rise to the ilium, ischium, and pubis. According to Adair, they appear in the order named, and are all present by the nineteenth week of pregnancy. The remaining 9 centers—the so-called epiphyseal centers—are secondary, and do not develop until a considerably later period, some of them not until after the age of puberty.

The sacrum at birth is likewise partly bony and partly cartilaginous. It is made up of 21 distinct bones, each of which is derived from a single center of ossification. The 21 centers are arranged as follows: 1 for each vertebral body (5); 3 for the alæ on either side (6); and 2 for the arches of each vertebra (10). To these must be added the various epiphyseal centers which appear later. The cartilage gradually becomes ossified, and the various component parts of the sacrum fuse together. The alæ are the first portions to become united, after which the vertebral bodies gradually become welded together, the fusion extending from below upward. According to Litzmann, the bodies of the sacral vertebræ are not entirely united until the seventh year, and complete ossification of the sacrum is not effected until the twenty-fifth year. Figure 20 represents the disarticulated pelvis of a child three years old, and clearly shows the extent to which ossification has progressed at that age.

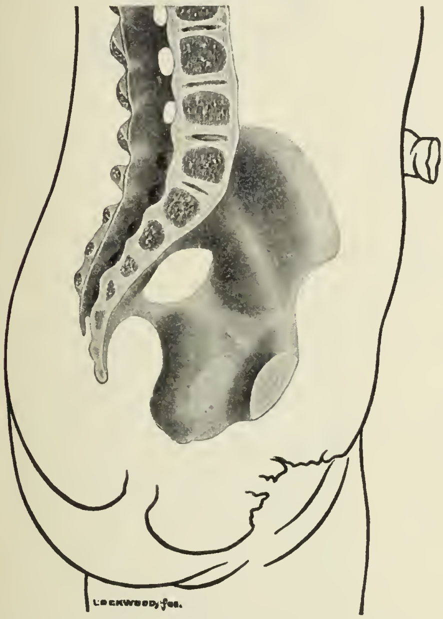

Fig. 18.—Sagittal Section Showing Relative Proportion of Bone and Cartilage in the Pelvis of a Newly Born Child. × 1.

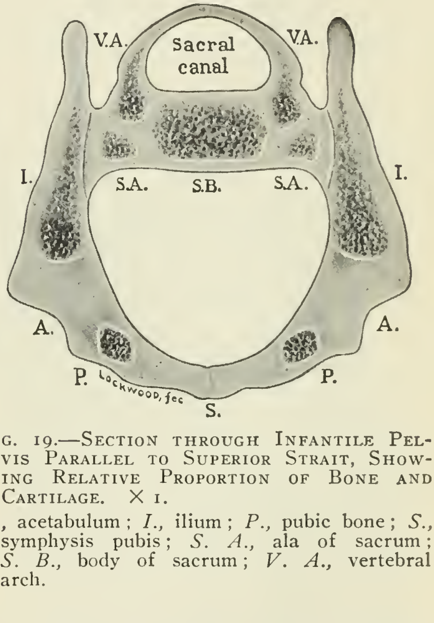

Fig. 19.—Section through Infantile Pelvis Parallel to Superior Strait, Showing Relative Proportion of Bone and Cartilage. × 1.

A., acetabulum; *I.*, ilium; *P.*, pubic bone; *S.*, symphysis pubis; *S. A.*, ala of sacrum; *S. B.*, body of sacrum; *V. A.*, vertebral arch.

The pelvis of the new-born child differs from that of the adult not only in being made up of a large number of bones, which are united by cartilage, but more particularly in its characteristic shape. This is clearly seen upon comparing Figures 22 and 23, which represent vertical mesial sections through the trunk of a new-born child and of an adult woman. In the former the vertebral column is almost vertical, and its lumbar curvature practically absent. The promontory is very slightly marked, and is situated at a much higher level than in the adult. The sacrum is almost straight from above downward, but presents a more marked transverse concavity than in the adult. Its alæ are only slightly developed, and as a consequence the pelvis is relatively narrower. The iliac fossæ are almost vertical, and the horizontal rami of the pubis are far shorter than in the adult. The pubic arch is much more angular, while the pelvic inclination is decidedly greater. The superior strait is narrower and more

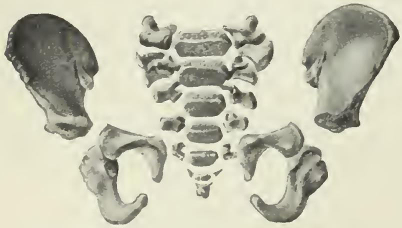

Fig. 20.—Disarticulated Pelvis of Three-year-old Girl. × ⅓.

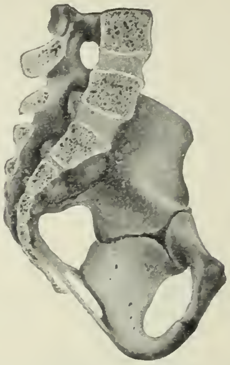

Fig. 21.—Sagittal Section through Pelvis of Five-year-old Girl. × ⅓.

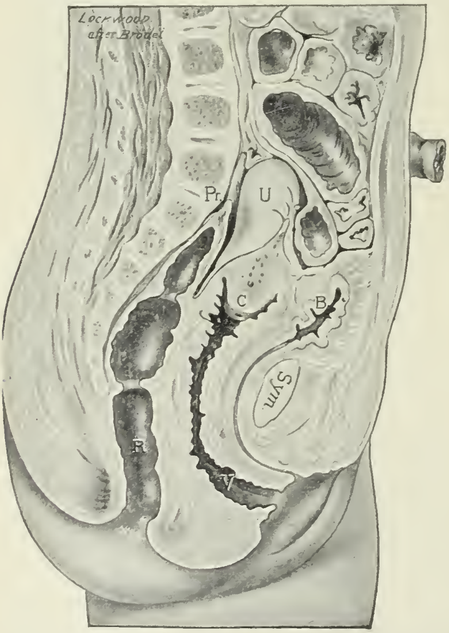

Fig. 22.—Sagittal Section through Body of Newly Born Child.

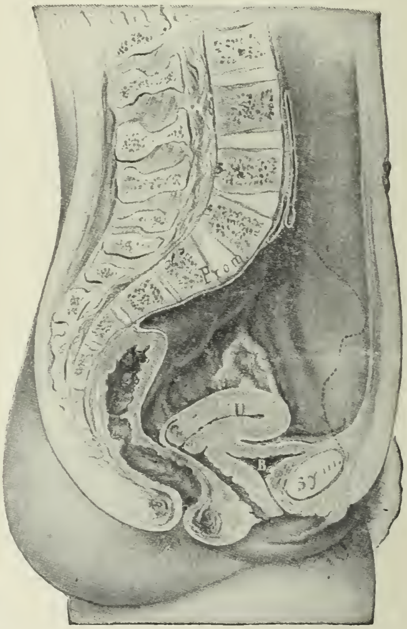

Fig. 23.—Sagittal Section through Adult Woman (Kelly); Reduced to the Same Size as Figure 22.

angular in shape, the relation between the conjugata vera and the transverse diameter being 100 to 105, instead of 100 to 122.5, as in the adult. The cavity of the pelvis is relatively much smaller, and is distinctly funnel-shaped. The anteroposterior and transverse diameters of the pelvic outlet, when expressed in terms of the conjugata vera, are respectively 93 and 73, instead of 104.5 and 100 as in the adult.

As we have already indicated, sexual differences make their appearance at a very early period. Fehling showed that they could be detected as early as the fourth month, when he found that the first sacral vertebra was wedge-shaped in the female, instead of cuboidal as in the male. His results have since been confirmed by a number of observers, among whom Balandin, Jürgens, and Arthur Thompson may be mentioned; my own work also corroborates their statements. To recapitulate, the pelvis of the female fœtus or new-born child presents the following characteristics as compared with that of the male: The pelvic canal is less funnel-shaped, the pubic arch is wider, the sacrosciatic notches are larger, and the lumbar region of the spinal column is more markedly curved.

Transformation of Fœtal into Adult Pelvis.—The mechanism by which the pelvis of the fœtus is converted into the adult form is of interest, not only from a scientific, but also from a practical, point of view, as it affords important information concerning the mode of production of certain varieties of deformed pelves.

The earliest investigations upon this subject were made by De Frémery, and Denman, who were followed by Litzmann, Duncan, Fehling, Schroeder, Veit, Meyer, and others. At present it is generally believed that in the evolution of the form of the pelvis two sets of factors—developmental and inherent tendencies, and mechanical influences—are concerned. That the process is not entirely the result of the action of mechanical forces is manifested by the existence of sexual and racial differences in the adult pelvis, but especially by the presence of the former in the fœtal pelvis, long before it has been subjected to the usual mechanical influences. On the other hand, the mechanical influences which come into play after birth are identical in both sexes, but despite this fact the sexual differences become still further accentuated as puberty is approached.

The part played by developmental and hereditary influences was clearly demonstrated by Litzmann, who showed that the female sacrum is characterized by a marked increase in width as compared with that of the male. At birth, in both sexes, the body of the first sacral vertebræ is twice as broad as the alæ (100 to 50), but in the adult the relation becomes 100 to 76 in the female, and 100 to 56 in the male, indicating a much more rapid growth of the alæ in the former. Falk, in 1908, held that all the changes in the developing pelvis are due to similar causes, and that the influence of the various mechanical factors is merely accessory.

The effect exerted by mechanical influences has been particularly studied by Duncan, Meyer, Veit, and Schroeder, while Kehrer has insisted upon the part played by muscular action. According to Schroeder, three mechanical forces take part in bringing about the final shape of the pelvis—namely, the body weight, the upward and inward pressure exerted by the heads of the femora, and the cohesive force exerted at the symphysis pubis.

So long as the child remains constantly in the recumbent position these forces are in abeyance, but as soon as it sits up or walks the body weight is transmitted through the vertebral column to the sacrum, and, as the center of gravity is anterior to its promontory, the force transmitted is resolved into two components, one of which is directed downward and the other forward. Accordingly, the two together tend to force the promontory of the sacrum downward and forward toward the symphysis pubis, a process which can only be accomplished by the sacrum rotating about its transverse axis, so that its tip tends to become displaced both upward and backward. This displacement, however, is resisted by the strong sacrosciatic ligaments, which therefore permit of only slight extension, with the result that the partly cartilaginous sacrum becomes bent upon itself just in front of its axis—*i. e.,* about the middle of its third vertebra—so that its anterior surface becomes markedly concave from above downward, instead of flat as it was previously. At the same time the body weight forces the bodies of the sacral vertebræ forward, so that they project slightly beyond the alæ, thereby diminishing the transverse concavity of the sacrum.

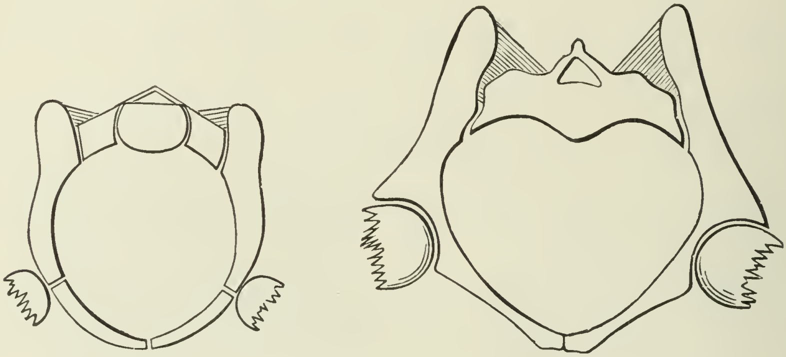

FIG. 24. FIG. 25.

FIGS. 24, 25.—DIAGRAMMATIC REPRESENTATIONS OF SECTIONS THROUGH THE INFANTILE AND ADULT PELVIS (Schroeder).

As the anterior surface of the sacrum is wider than its posterior, the bone tends to sink down into the pelvic cavity under the influence of the body weight, and would prolapse completely into it were it not held in place by the strong posterior iliosacral ligaments, which suspend it, so to speak, from the posterior superior spines of the ilium. Accordingly, as the sacrum is pushed downward into the pelvic cavity it exerts traction upon these ligaments, which in turn drag the posterior superior spines inward toward the middle line, and consequently tend to rotate the anterior portions of the innominate bones outward. Excessive outward rotation is prevented, however, by the cohesive force exerted at the symphysis, but particularly by the upward and inward pressure exerted by the heads of the femora. Practically, then, the iliac bone becomes converted into a two-armed lever, with the articular surface of the sacrum as a fulcrum; as a consequence, it bends at its point of least resistance, which is just anterior to the articulation, and thus gives the pelvis a greater transverse and a lesser anteroposterior diameter (Figs. 24, 25). At the same time it must be remembered that a considerable part of the transverse widening is more apparent than real, and is due to the relative shortening of the conjugata vera by the downward and forward displacement of the promontory of the sacrum.

It is apparent that the forces just mentioned must act in identically the same manner in the two sexes, so that, while they may serve to explain many points in the transformation of the fœtal into the adult pelvis, they fail to give a satisfactory explanation of its sexual differences, and we are therefore compelled to agree with Falk, Fehling, Freund, Joessel, and Breus and Kolisko that the latter must owe their origin to certain congenital tendencies concerning whose nature we are as yet ignorant.

Breus and Kolisko insist that too great stress has been laid upon the action of mechanical forces in the production of the ultimate shape of the pelvis, and hold that the relative flattening of the superior strait is due not so much to the downward and forward displacement of the base of the sacrum as to the unequal rate of growth before puberty of the sacrum and the several component parts of the innominate bones. In making this contention, they lay great stress upon the so-called terminal length of the latter. This includes not only the linea terminalis, but also its imaginary continuation, which extends from the ventral margin of the sacro-iliac articulation to the iliac crest just above the superior posterior spine (Figs. 26, 27). In the normal adult pelvis, the terminal length measures from 19.5 to 21 centimeters, and is divided into three parts—the sacral, iliac, and pubic portions. The first extends from the posterior margin of the iliac crest to the ventral margin of the articular surface, the second from the latter to the line upon the linea terminalis which indicates the union of the iliac and pubic bones, and the third from that point to the anterior end of the pubic bone. These portions measure 6.5 to 7, 6 to 6.5, and 7 to 7.5 centimeters, respectively, and therefore are of practically equal length. During the period of development, the sacral portion grows from the cartilage covering the iliac crest, the iliac portion from the upper limb of the Y-shaped cartilage of the acetabulum, and the pubic portion from the latter as well as from the symphyseal cartilage.

Up to the seventh or eighth year the sacrum increases steadily in width, and then ceases to grow until just before puberty, when it rapidly attains its full development. During the former period the superior strait grows relatively more rapidly in its transverse diameter, and therefore assumes a flattened shape. Normally, the iliac portion of the innominate bone increases steadily in length, until it has attained its full development just before puberty, while the sacral and pubic portions grow much more slowly. Accordingly, as a result of these variations, combined with the arrested growth of the sacrum, the anteroposterior diameter of the superior strait will at some time equal or exceed the transverse diameter in length, so that between the eighth and twelfth years the pelvic inlet tends to become round or even oval in shape, with its long diameter extending anteroposteriorly. This, however, is only a transient phenomenon, as shortly before puberty the sacrum suddenly begins to increase rapidly in width, and the pubic bones in length, so that the superior strait reassumes its typical flattened shape with the long diameter extending transversely.

Breus and Kolisko, therefore, contend that these variations indicate that the changes in shape of the pelvis must be attributed to something more than mere mechanical influences, since the latter come into play in infancy and continue as long as the individual is able to sit up or walk. Were they the only factors concerned, the pelvis would necessarily continue to become more and more flattened, until it had attained its ultimate form, whereas the occurrence of a rounded superior strait between the eighth and twelfth year clearly indicates that some other factor must be concerned. As yet they have advanced no explanation for the variable rate of growth of the sacrum and the component parts of the innominate bone, but they nevertheless hold that its occurrence precludes the acceptance of the mechanical theory to the exclusion of all others, while at the same time they admit that the latter may also play an important part in the development of the pelvis.

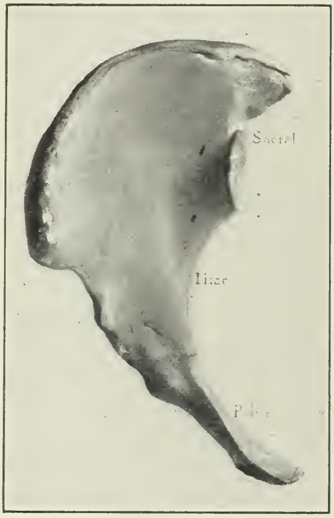

Fig. 26.—Showing Terminal Length as seen from Above. × ⅓.

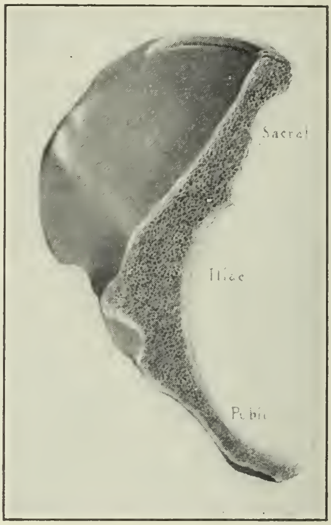

Fig. 27.—Showing Terminal Length as seen from Below. × ⅓.

The effect of the mechanical factors is particularly emphasized in the production of certain varieties of contracted pelvis, which have been studied by Meyer and Schroeder. In rare instances, as in one recorded by Gurlt, none of the mechanical forces had come into play, and then one has an opportunity of studying the development of the pelvis in their absence. In Gurlt's case, autopsy upon a thirty-one-year-old hydrocephalic woman, who had been bedridden since infancy and had never sat or walked, showed that the pelvis had retained its fœtal characteristics.

The cohesive force exerted at the symphysis pubis cannot act by itself, as it is manifested only when the force exerted by the body weight causes a tendency toward gaping of the pubic bones. Likewise, the effect of the upward and inward force exerted by the femora cannot be observed by itself, as this force comes into play only when it has to react against that resulting from the body weight. Nor has the action of the body weight alone ever been observed, though theoretically it might be noted in an individual presenting a split pelvis (congenital lack of union at the symphysis pubis) who had never walked. Its action, however, has been studied experimentally by Freund, who suspended a cadaver by the iliac crests after cutting through the symphysis, when he found that the innominate bones gaped widely.

The effect of the combined action of the body weight and the force exerted by the femora has been studied by Litzmann in cases of congenital absence of the symphysis pubis. In such circumstances there is a marked transverse widening of the posterior portion of the pelvis, while the force exerted by the femora causes the anterior portions of the innominate bones to become almost parallel.

The action of the body weight and the cohesive force exerted at the symphysis, without the upward and inward pressure exerted by the femora, can be studied in individuals whose lower extremities are absent, and occasionally in cases of congenital dislocation of the hips. Holst has described a case in which the lower extremities were congenitally absent, the pelvis being characterized by a marked increase in width and a marked decrease in its anteroposterior diameter. Owing to the excessive pressure exerted upon the tubera ischii in the absence of the counteracting force exerted by the femora, the innominate bones are rotated in such a manner as to turn their crests inward and the tubera ischii outward, thus producing a considerable transverse widening of the inferior strait. More or less similar changes may be observed in cases of congenital dislocation of the hip if the patients have never walked.

The effect of the various mechanical influences is particularly emphasized when they are exerted upon pelves whose bones are softened by disease, as in rachitis and osteomalacia. Consideration of the changes so produced will be deferred until the study of the deformed pelves is taken up.

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CHAPTER II

THE FEMALE ORGANS OF GENERATION

For convenience in description and on account of their differences in function, the female organs of generation are divided into two groups—the external and the internal—the vagina being usually classed with the former. The external organs, together with the vagina, serve more especially for copulation, while the internal organs are directly concerned with the development and birth of the fœtus.

THE EXTERNAL GENERATIVE ORGANS

The term pudendum is occasionally applied to the external organs of generation, although the more common designation is the *vulva*. This includes everything which is visible externally from the lower margin of the pubis to the perineum—namely, the mons veneris, the labia majora and minora, the clitoris, vestibule, hymen, urethral opening, and various glandular and vascular structures.

Mons Veneris.—The mons veneris is the name given to the fatty cushion which rests upon the anterior surface of the symphysis pubis. After puberty the skin over it is covered by a growth of crinkly hair, which is sometimes described as the *"escutcheon."* Generally speaking, the distribution of the pubic hairs differs considerably in the two sexes. In the female they occupy a triangular area whose base corresponds to the upper margin of the symphysis, while a few hairs extend down over the outer surface of the labia majora. In the male, on the other hand, the escutcheon is not so circumscribed, as the hairs composing it extend triangularly upward toward the umbilicus and downward over the inner surface of the thighs. These differences were described in detail by Ploss, and at one time it was believed that they might be of value in determining the sex in doubtful cases. They are, however, not altogether characteristic, and my own experience has convinced me that the female escutcheon not infrequently approaches the male type.

Vulva.—In the restricted sense, the term vulva (from the Latin *valva,* a folding door), or rima pudendi, is applied only to the structures lying beneath the mons veneris. Its position varies according to the inclination of the pelvis, but it usually runs horizontally when the woman is in the erect position. It presents marked individual variations in appearance, but its most noteworthy differences are dependent upon the age of the person and whether or not she has borne children.

Labia Majora.—On either side of the vulva extends a rounded mass of tissue, the labium majus. The labia majora vary in appearance, according to the amount of fat beneath them. They are less prominent after childbearing, and in old age usually assume a shriveled appearance. Ordinarily they measure 7 to 8 centimeters in length, 2 to 3 centimeters in width, and 1 to 1.5 centimeters in thickness. They are somewhat lozenge-shaped, and become narrower at their lower extremities. In children and virginal adults they usually lie in close apposition and completely conceal the underlying parts, whereas in multiparous women they often gape widely. Until recently it was usually stated that they were connected above and below by the anterior and posterior commissures of the vulva, but Luschka has shown that they are directly continuous with the mons veneris above, and fade away into the perineum posteriorly.

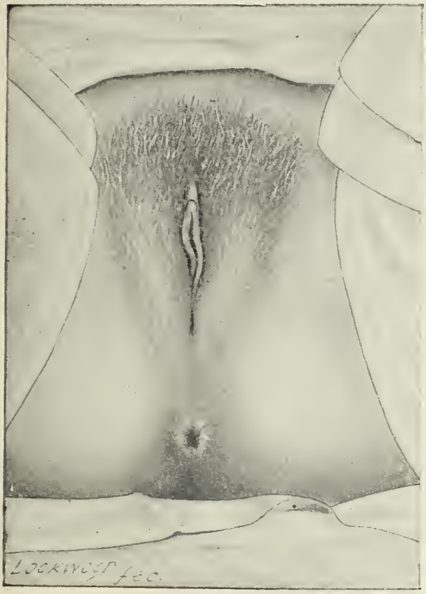


Fig. 28.—External Genitalia of Nulliparous Woman, Labia in Contact.

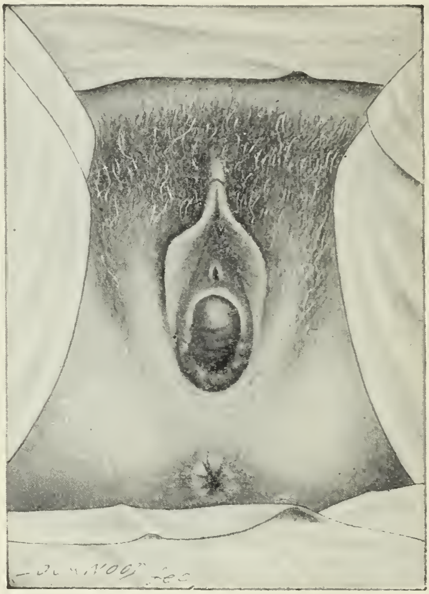


Fig. 29.—External Genitalia of Multiparous Woman, Labia Spread Apart.

Each labium majus presents two surfaces, an outer and an inner. The outer surface corresponds in structure to the adjacent skin, and after the age of puberty is more or less thickly covered with hair. In women who have never borne children the inner surface is moist and resembles a mucous membrane in appearance; whereas in multiparæ it becomes more skinlike, but is not covered with hair. It is richly supplied with sebaceous glands. Beneath the skin there is a layer of dense connective tissue, which is rich in elastic fibers and adipose tissue, but does not contain muscular elements. Beneath this layer, which corresponds to the tunica dartos of the scrotum, is a tolerably dense mass of fat, to which the labium owes the greater part of its size. This fatty tissue is supplied with an abundant plexus of veins, which may rupture as the result of external violence or injury sustained during labor, and give rise to an extravasation of blood or hematoma.

The labia majora are analogous to the scrotum in the male, and at their upper ends receive the termination of the round ligaments. Exceptionally one or both of the inguinal canals, which in the female are designated as the canals of Nuck, may remain patent, so that in rare instances there results a hernial sac which usually contains intestine, but occasionally the tube or ovary, and possibly even the uterus.

Labia Minora.—On spreading apart the labia majora two triangular structures are seen, which meet together at the uppermost portion of the vulva and more or less resemble a cockscomb in appearance. These are the labia minora or *nymphæ,* so-called because they were supposed to direct the course of the urine. They vary greatly in size and shape, and in nulliparous women are usually hidden by the labia majora. In multiparæ, on the other hand, they project beyond them.

Each labium majus consists of a thin fold of tissue, which when protected presents a moist, reddish appearance, similar to that of a mucous membrane. It is, however, covered by stratified epithelium, into which project numerous papillæ. It has no hairs upon it, but contains many sebaceous follicles and occasionally a few sweat glands. The interior of the labial folds is made up of connective tissue, in which are many vessels and a few nonstriated muscular fibers, so that they are classed among the erectile structures. They are extremely sensitive, and are abundantly supplied with the several varieties of terminal nerve-endings, as has been shown by the work of Krause, Carrard, and Webster.

The labia minora converge anteriorly, each dividing toward its upper extremity into two lamellæ. Of these the two lower fuse together and form the *frenulum clitoridis,* while the upper ones make the *preputium.* Posteriorly they either pass almost imperceptibly into the labia majora or approach the middle line as low ridges, which fuse together and form the *frenulum labiorum* or *fourchet* (Luschka, Cullingworth, and Nagel).

According to Nagel, the labia minora are homologous with the skin upon the under surface of the penis. They frequently become considerably hypertrophied, either from unknown causes or as a result of masturbation. Among the Hottentots they assume immense proportions, and project from the vulva in the form of an apron some centimeters long. Among certain uncivilized races voluminous labia minora are considered to enhance the beauty of their possessors; and it is generally believed that artificial means are employed to bring about an increase in their size, but Marius Wilson considers that it is the result of natural causes. According to Ploss, the Nubians and many other races practice *infibulation* as part of their religious ceremonial. In this operation, which is performed just before the age of puberty, the edges of the labia are freshened with a knife, and then sutured together in such a manner as to leave an opening only large enough to permit the escape of the menstrual flow. In such circumstances a second operation is necessary before marriage can be consummated.

Clitoris.—The clitoris is situated at the most anterior portion of the vulva, and projects between the branched extremities of the labia minora, which form its prepuce and frenulum. It is the analogue of the penis in the male, from which it differs in not possessing a corpus spongiosum, and in not being perforated by the urethra. It consists of a glans, a corpus, and two crura. According to Temesváry, the glans is made up of spindle-shaped cells, suggesting those of the ovarian stroma; while the corpus contains two corpora cavernosa, in whose walls are nonstriated muscle fibers. The crura are long, narrow structures which arise from the inferior surface of each ischiopubic amus and fuse together, just below the middle of the pubic arch, to form the body of the clitoris. The clitoris is usually a rudimentary organ and rarely exceeds 2 centimeters in length, even when in a state of erection. It is sharply bent on itself, owing to traction exerted upon it by the labia minora. As a result, its free end looks downward and inward toward the vaginal opening. The glans, which rarely exceeds a small pea in size, is covered by squamous epithelium, is richly supplied with nerve-endings, and is extremely sensitive. The entire clitoris is very erectile, and its vessels are connected with the vestibular bulbs by means of the pars intermedia. Figure 30 gives a good idea of the relations of the clitoris, its crura, and the vestibular bulbs. We are indebted to Kobelt for most of our knowledge concerning this organ, and since the appearance of his monograph, in 1844, the clitoris has been regarded as the chief seat of voluptuous sensation.

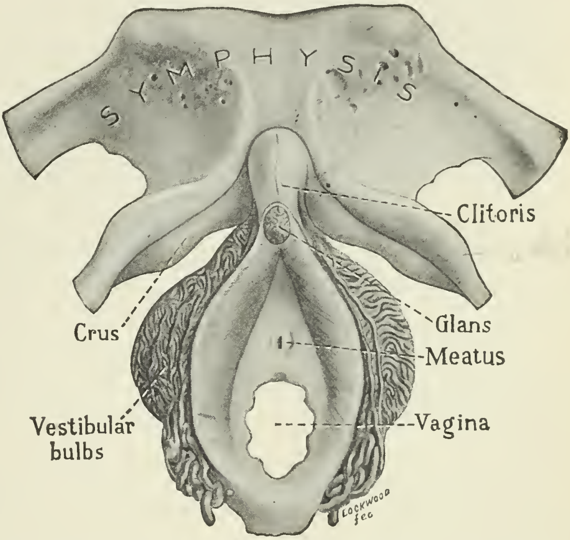


Fig. 30.—Preparation Showing Clitoris and Its Vascular Supply. (Modified from Chrobak and Rosthorn.)

About the middle of the last century Baker Brown proposed its amputation as a panacea for nearly all the ills to which women are subject, and for a short time the operation of *clitoridectomy* enjoyed a considerable vogue, but has since been completely abandoned. Among many aboriginal races the same operation had been performed from time immemorial as a religious rite—"girl circumcision." Occasionally the clitoris may become so hypertrophied as to resemble the penis, and not a few cases of so-called hermaphroditism are to be explained by this abnormality.

Vestibule.—The vestibule is the almond-shaped area which is inclosed between the labia minora and extends from the clitoris to the fourchet. It is the remnant of the urogenital sinus of the embryo, and is perforated by four openings—the urethra, the vaginal opening, and the ducts of Bartholin's glands. Considerable uncertainty exists as to its boundaries, for the reason that the French anatomists usually describe it as the triangular area, bounded above by the labia minora and below by the vaginal opening. The posterior portion of the vestibule, between the fourchet and the vaginal opening, is called the *fossa navicularis*. This is rarely observed except in nulliparous women, as it usually becomes obliterated after childbirth.

Vestibular Glands.—In connection with the vestibule, certain glandular structures—the *glandulæ vestibulares majores* and *minores*—are usually described. The former are designated as *Bartholin's glands,* or the glands of Duverney, who first described them in the cow. They are two small compound racemose glands, varying from a pea to a small bean in size, and are situated beneath the vestibule, on either side of the vaginal opening. They lie under the constrictor muscle of the vagina, and in a few instances are found to be partially covered by the vestibular bulbs. Their ducts, from 1.5 to 2 centimeters long, open upon the sides of the vestibule just outside the lateral margin of the vaginal orifice. In caliber they are usually small, and the lumen will admit only a bristle. Under the influence of sexual excitement the glands secrete a small amount of yellowish material. The ducts frequently harbor gonococci, which may gain access to the gland and cause it to suppurate, so that the entire labium becomes distended by a collection of pus.

The glandulæ vestibulares minores are a number of small mucous glands which open upon the upper portion of the vestibule. Their orifices are occasionally several millimeters in diameters, and in such cases they are designated as lacunæ.

Urethral Opening.—The mouth of the urethra, or urinary meatus, is situated in the middle line of the vestibule, 1 to 1.5 centimeters below the pubic arch and a short distance above the vaginal opening. It usually presents a puckered appearance, and its orifice appears as a vertical slit, which on distention is 4 or 5 millimeters in diameter. The *para-urethral ducts* open upon the vestibule on either side of the urethra, and occasionally upon its posterior wall, just inside its mouth. They are of small caliber, 0.5 millimeter in diameter, of varying length, and in this country are generally known as Skene's ducts. They were, however, described by Malpighi in the seventeenth century. Considerable discussion has arisen as to their origin, and certain observers, notably Kocks, believe that they represent the lower extremities of the wolffian ducts. Most authorities, however, do not share this view, and believe that they are simply exaggerated lacunæ.

Vestibular Bulbs.—Lying beneath the mucous membrane of the vestibule, on either side, are the vestibular bulbs. These are almond-shaped, erectile bodies, 3 to 4 centimeters long, 1 to 2 centimeters wide, and 0.5 to 1 centimeter thick. They lie in close apposition to the ischiopubic rami, and are partially covered by the ischiocavernosus and constrictor vaginæ muscles. Their lower ends usually terminate about the middle of the vaginal opening, while their anterior extremities extend upward toward the clitoris, where they are united by the pars intermedia through which the blood from them reaches that organ. They were first described by Kobelt, and their vascular connections have been exhaustively studied by Gussenbauer.

Embryologically, they correspond to the corpus spongiosum of the penis. During parturition they are usually pushed up beneath the pubic arch, but, as their posterior ends partially encircle the vagina, they are liable to be injured, and their rupture may give rise to a hematoma of the vulva, or to profuse external hemorrhage if the tissues covering them are torn through.

Vaginal Opening and Hymen.—The vaginal opening occupies the lower portion of the vestibule and varies considerably in size and shape in different individuals. In virgins it is entirely hidden from view by the overlapping labia minora, and, when exposed by folding them back, appears almost completely closed by a membranous structure known as the hymen.

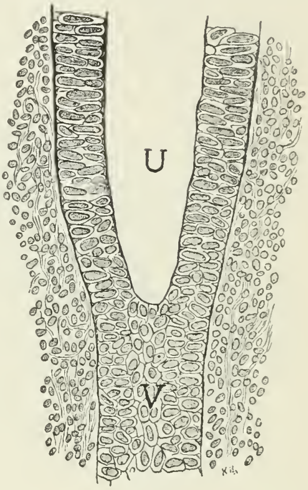


Fig. 31.—Longitudinal Section Showing Transition from the Cylindrical Epithelium of the Uterus to the Cuboidal Epithelium of the Vagina.

From a 10-centimeter embryo (Nagel). *U.*, uterus; *V.*, vagina.

The hymen presents marked differences in shape and consistence. In the new-born child it is a redundant structure which projects considerably beyond the surrounding parts, while in adult virgins it is a membrane of varying thickness which closes the vaginal opening more or less completely, and presents an aperture which varies in size from a pin's point to a caliber which will readily admit the tip of one or even two fingers. The hymeneal opening is usually crescentic or circular in shape—*hymen semilunaris* or *annularis.* In rare instances it may assume other forms, which have been studied more particularly by Dohrn and Budin; the most important varieties being the cribriform, septate, and denticulate or fimbriated hymen. In very rare instances the membrane may be imperforate and lead to the retention of the menstrual discharges. Dohrn devoted particular attention to the fimbriated variety, and stated that it might be mistaken by an inexperienced observer for a ruptured hymen, so that this type possesses some little medicolegal interest.

According to Lubosch, the embryology of the hymen is still in need of clarification. Nagel, Gellhorn, Klaatsch and others hold that it represents the area at which the lowermost portion of the vagina breaks through the müllerian eminence. In early embryos the vagina is composed of a solid mass of epithelial cells, and after proliferating rapidly for a time those most centrally situated begin to degenerate so that a lumen is produced, except at the lower extremity of the mass, where the cells persist and give rise to the hymen. The hymen, therefore, is a fold of tissue presenting a structure similar to that of the vagina—namely, a connective-tissue core with numerous elastic fibers—is covered on either side by a layer of stratified epithelium, in which are numerous papillæ containing vessels and occasionally nerve-endings. Taussig, on the other hand, holds that the hymen does not represent the lowermost portion of the vagina, but is derived from a definite projection into it some distance above its opening into the urogenital sinus.

The hymen may vary markedly in consistence in different individuals. According to Dohrn, many types are observed—from a delicate structure resembling a spider's web to a fleshy, ligamentous, or even cartilaginous membrane, which in rare instances has even been described as "bony." In the matter of elasticity, again, wide variations are met with, some hymens being so delicate that they rupture upon the slightest touch, while others still remain unbroken even after considerable distention.

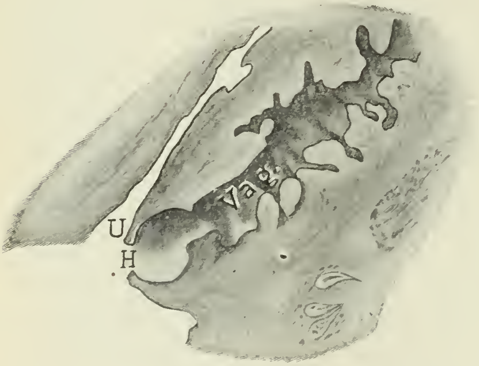


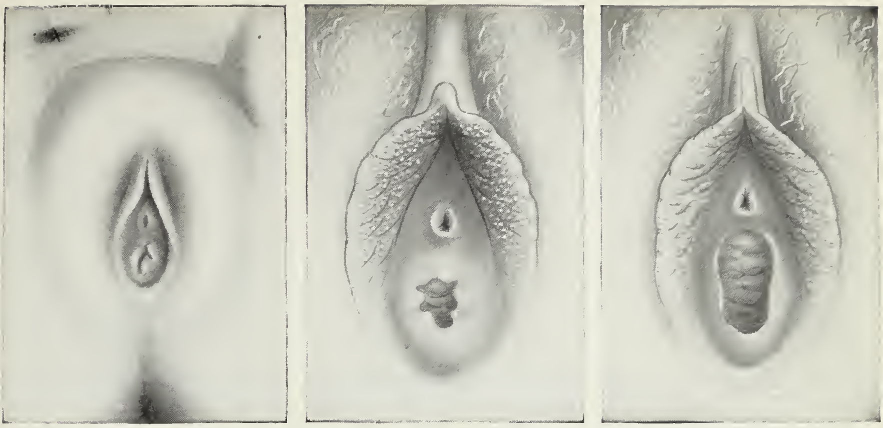
Fig. 32.—Sagittal Section through the Lower Portion of the Vagina of a 14-Centimeter Embryo (Nagel).
U., urethra; *H.*, hymen; *Vag.*, vagina.

As a general rule the hymen ruptures at the first coitus, tearing at several points, usually in its posterior portion. The edges of the tears soon cicatrize, and the hymen becomes permanently divided into two or three portions, which are separated by narrow slits extending down to its base (Plate II). The extent to which rupture occurs varies with the structure of the hymen and the degree to which it is distended, being most marked when it is delicately formed.

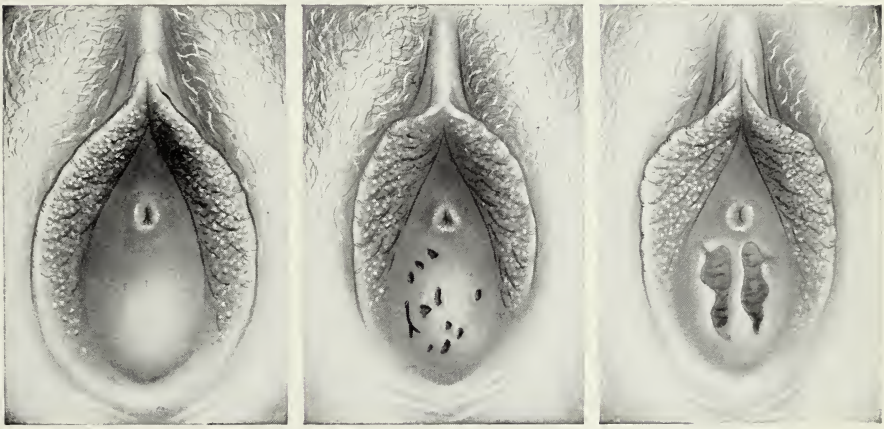
Although it is generally believed by the laity that its rupture is associated with hemorrhage, this is by no means always the case, though in rare instances such a profuse loss of blood may occur as to require surgical intervention. This idea is probably based upon the biblical statement that loss of virginity is always associated with loss of blood. Nor is it unreasonable to suppose that considerable bleeding usually occurred among the Hebrews of the biblical period, inasmuch as the girls frequently married before the age of puberty, so that marked disproportion must often have existed between the size of the male and female organs. On the other hand, it must be remembered that where Western civilization prevails full sexual development has usually been attained before marriage.

In rare instances the membrane may be very resistant and surgical interference be required before coitus can be accomplished. Occasionally instead of giving way in the middle, the hymen may be torn loose from its base in the attempt at coitus, while in other cases the penis may dilate the urethral canal instead of entering the vagina. Neugebauer has collected an interesting series

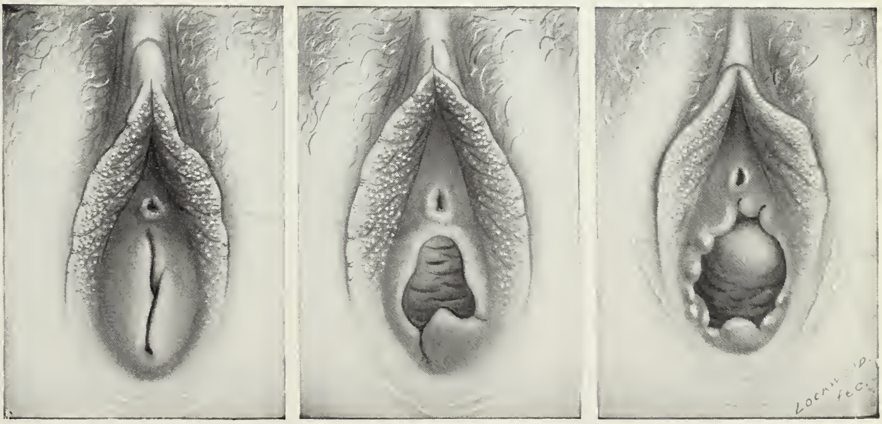
PLATE II.



Infantile. Annular. Semilunar.



Imperforate. Cribriform. Septate.



Vertical. Normal injury at coitus. Carunculæ myrtiformes.

SEVERAL VARIETIES OF HYMEN.

of injuries occurring during coitus, many of which were due to the presence of a very resistant hymen.

The changes in the hymen following coitus are often of medicolegal interest, as the physician is occasionally called upon to testify as to the virginity of an individual. Unfortunately, however, it is not always possible to arrive at a decisive conclusion as to this point. In occasional instances the hymen may be destroyed in early childhood, either as the result of masturbation or as a consequence of attempting to get rid of seatworms. Among certain Eastern races, again, it is ruptured in early childhood for purposes of cleanliness. On the other hand, the hymen may not be torn, despite repeated coitus; whereas, in other instances, the denticulate or fimbriated type may be mistaken for one which has been ruptured. Haberda, when Professor of Legal Medicine in Vienna, stated that he was able to make a positive diagnosis of loss of virginity in only about 50 per cent of the medicolegal cases which he had examined. He believed that in many instances it is impossible to determine whether coitus has taken place or not, unless the individual is seen immediately after the attempt, before the torn surfaces have had an opportunity to unite. Achenbach, in 1890, collected 25, and Kanony, some years later, 43 instances of pregnancy occurring in women with unruptured hymens. I have seen a patient in whom conception had occurred through a hymen which presented only a pin-point opening, as well as another in whom an elastic hymen had become invaginated sufficiently to admit the penis, but did not rupture until it yielded to the advancing head at labor.

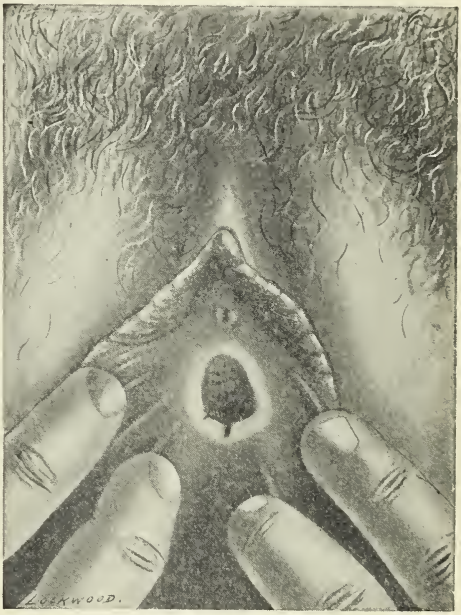


Fig. 33.—Almost Unruptured Hymen after Childbirth (Budin).

The changes produced by childbirth are much more marked than those following coitus, and, as a rule, are readily recognized. As the result of the distention incident to the birth of the child, the hymen undergoes pressure necrosis in various places, and after the puerperium the remnants are represented by a number of cicatrized nodules of varying size—the *carunculæ myrtiformes* (Plate II). Their significance was first emphasized by Shroeder. Practically speaking, they are infallible signs of previous childbearing, though occasionally they may follow great distention and long-continued pressure incident to the removal of large tumors through the vagina. In rare instances the injuries resulting from childhood are extremely slight, and very exceptionally are entirely lacking. Such cases have been reported by Hyerneaux, Tolberg, Hyrtl, and Budin. Figure 33 shows the external organs of one of Budin's patients who had given birth to a full-term child.

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THE VAGINA

The vagina is a musculomembranous tube which extends from the vulva to the uterus, and is interposed between the bladder and the rectum. It serves three important functions; it represents the excretory duct of the uterus, through which its secretion and the menstrual flow escape; it is the female organ of copulation; and, finally, it forms part of the birth canal at labor. Its course runs almost entirely within the pelvic floor, and it is therefore practically outside of the pelvic cavity. The vaginal canal presents a somewhat S-shaped curvature. The common statement that its course corresponds in direction to that of the pelvic axis is incorrect, since its lower third is parallel to the plane of the superior strait, while its upper portion presents a concavity corresponding to the curve of the rectum.

Anteriorly, the vagina is in contact with the bladder and urethra, from which it is separated by the vesicovaginal septum. Posteriorly, between its lower portion and the rectum, we have the perineum and rectovaginal septum; in its median portion it lies in close apposition with the rectum, while its upper portion is separated from it by Douglas's culdesac. In view of these relations, Schauta, for purposes of description, has divided its anterior wall into two parts—urethral and vesical—and its posterior wall into three—perineal, rectal, and peritoneal respectively. The urethral portion of the vagina is firmly united to the urethra and vesicovaginal septum, from which it can be separated only with some difficulty; whereas the vesical portion is loosely attached to the bladder and can be readily detached from it.

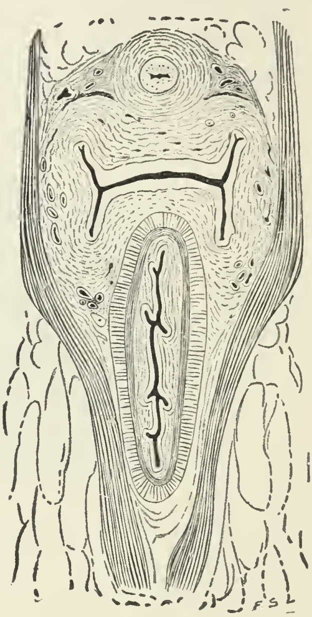

Fig. 34.—H-shaped Lumen of Vagina (Henle).

Normally the anterior and posterior walls of the vagina lie in contact, a slight space intervening between their lateral margins. When not distended, the canal presents an H-shaped appearance on transverse section, as was first pointed out by Henle. The vagina is capable of marked distention, as is manifested at childbirth, or when one attempts to pack it with gauze. The vagina and uterus meet at an acute angle, with its opening looking forward. The upper end of the vagina ends as a blind vault into which the lower portion of the cervix uteri projects. This vaginal vault, or, as it is usually designated, the *fornix,* for convenience of description, is subdivided into the anterior, posterior, and two lateral fornices. As the vagina is attached higher up upon the posterior than upon the anterior wall of the cervix, the posterior fornix is considerably deeper than the anterior.

The vagina presents considerable individual variations in length. Since it is united to the uterus at an acute angle, its anterior is always shorter than its posterior wall—6 to 8, and 7 to 10 centimeters respectively. The vagina is relatively longer in the new-born child than in the adult, and according to Luschka forms about 1/9 of the body length in the former as compared with 1/15 in the latter (Figs. 22 and 23).

Projecting from the middle line of both the anterior and posterior walls is a prominent longitudinal ridge—the anterior and posterior vaginal columns, the latter not infrequently being divided into two parts by a longitudinal furrow. In women who have not borne children numerous transverse ridges or *rugæ* extend outward from and almost at right angles to the vaginal columns, gradually fading away as they approach the lateral walls. They give to the surface a corrugated appearance, which is more marked in the early years of life, and gradually becomes obliterated after repeated childbirth, so that in old multiparæ the vaginal walls are often perfectly smooth. The vaginal columns are supposed to represent the remnants of the partition wall separating the ends of the two müllerian ducts, from which the vagina is derived.

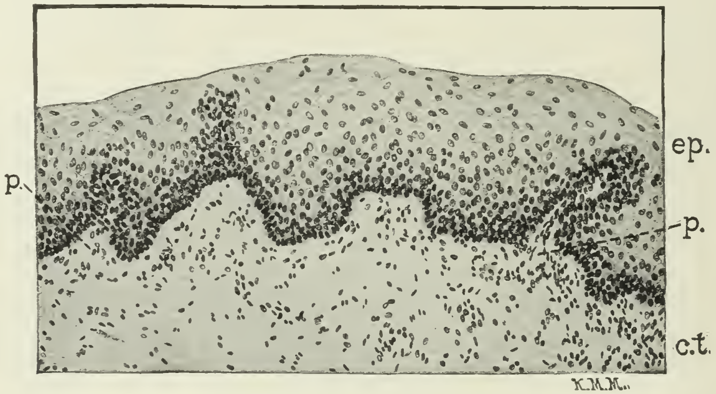

Fig. 35.—Vaginal Mucosa. × 90.
ep., epithelium; *p.*, papilla; *c.t.*, connective tissue.

The vaginal wall itself is composed of three layers—the mucous, the muscular, and the connective-tissue layers. The mucosa is composed of numerous layers of stratified epithelium, and closely resembles the skin in structure; but, as its surface is not exposed to the air, the horny layer is absent. The lowest layer of epithelium is distinctly columnar in appearance, while the cells immediately above it are polygonal in shape, and gradually become more and more flattened as the free surface is approached. Beneath the epithelium is the submucosa, a thin layer of connective tissue, which is rich in blood vessels. Offshoots from it extend up into the epithelium and form papillæ, just as in the skin, and scattered here and there through the submucosa are small lymphoid nodules. The mucosa is very loosely attached to the underlying connective tissue, as is manifested by the ease with which it can be peeled off at operations.

Nidercke, Gragert and all recent investigators have shown that from early infancy until after the menopause, the cells of the superficial layer of the mucosa contain considerable quantities of glycogen, which can readily be demonstrated by Best's method. Moreover, as indicated by Dierks, Adler, and others, the mucosa is constantly undergoing cyclic changes. These consist in a considerable thickening of its superficial portion by flattened almost colorless cells, which are cast off at the beginning of menstruation and reappear during the succeeding premenstrual period. On the other hand, the observations of Jessie L. King make it improbable that examination of the vaginal contents will permit the recognition of the various stages of the sexual cycle as may be done in many lower animals.

According to Nagel, Gebhard, and Waldeyer, the vaginal mucosa is devoid of glands, nor have I, in any of the large number of specimens examined, ever encountered them. Certain authors, on the other hand, affirm that they are sometimes present. It is true that in rare instances Veit and Davidsohn found a few structures which the latter considered represented aberrant cervical glands, but I do not believe that typical glands lined by cuboidal or cylindrical epithelium can be considered as normal constituents of the vagina. In women who have borne children one occasionally finds imbedded in the connective tissue masses of stratified epithelium, which may present a central cavity, and sometimes give rise to cystic formation. These, however, are not glands, but simply represent tags of mucosa which were buried during the repair of vaginal tears following labor. In other cases, cysts lined by ciliated epithelium, and lying outside of the mucosa, should be considered as derived from remnants of the wolffian ducts.

The muscular layer is not very sharply marked, and is usually described as being composed of two layers of nonstriated muscle—an outer, longitudinal, and an inner, circular layer. At the lower extremity of the vagina, Luschka described a thin band of voluntary muscle, the constrictor or *sphincter vaginæ*. This can always be found in perineal dissections, but for practical purposes the levator ani muscle is the real closer of the vagina.

Outside of the muscular layer is a layer of connective tissue which serves to connect the vagina with the surrounding parts. It is rich in elastic fibers, and contains an abundant venous plexus.

In the nonpregnant condition the vagina is kept moist by a small amount of secretion from the uterus; but in pregnancy a well-marked vaginal secretion is present, which, according to Döderlein and most subsequent observers, normally consists of a dry, white, curdlike material composed of cast-off epithelium and many bacteria, and presents a markedly acid reaction. A great deal of work has been done upon the bacterial flora of the vaginal secretion in pregnancy, but the question is still sub judice. All observers, however, agree that bacillary forms predominate, though cocci are not infrequently seen. From the time of Zweifel the acid reaction has been attributed to the presence of lactic acid, which is supposed to result from the breaking down of the glycogen contained in the mucosal cells by the bacilli of Döderlein. The reaction was originally tested by means of litmus. Gräfenberg determined it by titration; while Gragert was the first to study the hydrogen-ion concentration, which he placed at 6.7. As his determinations were made by colorimetric methods, it is probable that conclusive results will not be available until electrometric determinations have been made by means of the potentiometer.

The vagina possesses an abundant vascular supply, its upper third being supplied by the cervicovaginal branches of the uterine arteries, its middle third by the inferior vesical arteries, and its lower third by the median hemorrhoidal and internal pudic arteries. Immediately surrounding the vagina is an abundant venous plexus, the vessels from which follow the course of the arteries and eventually empty into the hypogastric veins.

The distribution of lymphatics has been very accurately studied by Poirier, who found that the lymphatics from the lower third of the vagina empty into the inguinal lymph glands, those from its middle third into the hypogastric, and those from its upper third into the iliac glands.

The vagina is formed by the fusion of the terminal ends of the müllerian ducts, which, according to Nagel, reach the urogenital sinus in embryos 2.5 to 3 centimeters long. As has already been said, when considering the development of the hymen, the vagina is originally solid, and is made up of a mass of polygonal epithelial cells, its lumen resulting from their degeneration, which commences at about the third month of gestation (Fig. 31).

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THE UTERUS

The uterus is a muscular structure, partially covered by peritoneum, and presents a cavity lined by mucous membrane. It is the organ of menstruation, and during pregnancy serves for the reception, retention, and nutrition of the ovum, which it expels at the time of labor by its contractions.

The nonpregnant uterus is situated in the pelvic cavity between the bladder and rectum, its inferior extremity projecting into the vagina. Almost its entire posterior wall is covered by peritoneum, the lower portion of which forms the anterior boundary of Douglas's culdesac; only the upper portion of the anterior wall is so covered, its lower portion being united to the posterior wall of the bladder by a tolerably thick layer of connective tissue.

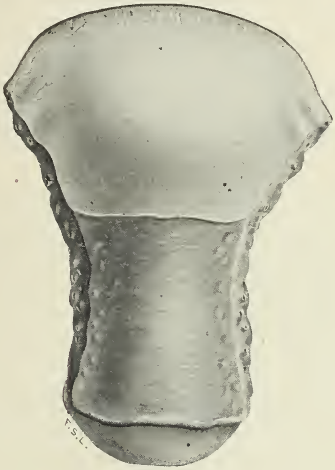

Fig. 36.—Anterior Aspect of Uterus. × 1.

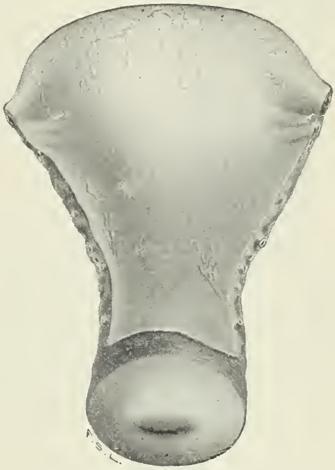

Fig. 37.—Posterior Aspect of Uterus. × 1.

Roughly speaking, the uterus resembles a flattened pear in appearance, and consists of two unequal parts: an upper triangular portion—the *corpus*—and a lower, cylindrical, or fusiform portion—the *cervix*. The anterior surface of the corpus is almost flat, while its posterior surface is distinctly convex. In view of the fact that the former, which looks downward and forward, rests upon the bladder, while the latter is in contact with the intestines, His has suggested that the surfaces be described as vesical and intestinal, instead of anterior and posterior, respectively. The fallopian tubes come off from the *cornua* of the uterus on either side—*i. e.,* at the junction of the superior and lateral margins—the convex upper margin between their points of insertion is called *fundus uteri.* The lateral margins extend from the insertion of the fallopian tubes on either side to the pelvic floor. They are not covered by peritoneum, but receive the attachments of the broad ligaments.

The uterus presents marked variations in size and shape, according to the age of the individual, and whether or not she has borne children. The infantile organ varies from 2.5 to 3 centimeters in length; that of adult virgins measures from 5.5 to 8, 3.5 to 4, and 2 to 2.5 centimeters in its greatest vertical, transverse, and anteroposterior diameters, respectively, as compared with 9 to 9.5, 5.5 to 6, and 3 to 3.5 centimeters in multiparous women. Virginal and parous uteri also differ considerably in weight, the former ranging from 40 to 50, and the latter from 60 to 70 grams. The relation between the length of the corpus and that of the cervix likewise varies widely. In the young child the former is only half as long as the cervix; in young virgins the two are of equal length, or the corpus may be slightly longer. In multiparous women, on the other hand, the relation is reversed, and the cervix represents only a little more than one third of the total length of the organ.

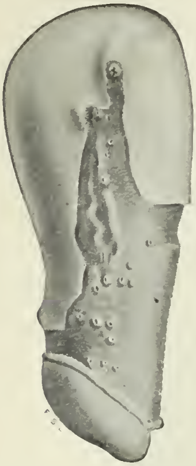

Fig. 38.—Lateral Aspect of Uterus, Showing Supravaginal and Infravaginal Portions of Cervix and Arrangement of Peritoneal Covering. × 1.

On the sagittal section it is seen that the great bulk of the uterus is made up of muscular tissue, and that the anterior and posterior walls of its body lie almost in contact, the cavity between them appearing as a mere slit, while that of the cervix is fusiform in shape with a small opening above and below—the internal and the external os.

In 1905, Aschoff pointed out that the lowermost portion of the uterine cavity forms a narrow canal—the *isthmus uteri,* and that the histological internal os is situated at the junction of its lower extremity with the cervical canal. Full discussion of its significance will be found in Stieve's monograph (1928). (Figs. 42 and 43.)

On frontal section the cavity of the body presents a triangular appearance, while that of the cervix retains its fusiform shape. After the childbearing period the triangular appearance becomes less pronounced, as its margins become concave instead of convex, as in the virginal condition.

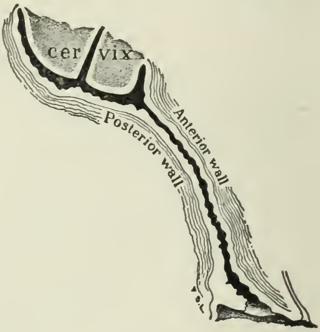

Fig. 39.—Showing Junction of Vagina and Cervix (Skene).

Cervix Uteri.—The cervix is the portion of the uterus which lies below the isthmus and the internal os. On the anterior surface of the uterus its upper boundary is roughly indicated by the point at which the peritoneum is reflected on to the bladder.

It is divided, by the attachment of the vagina, into two parts: the supravaginal and infravaginal portions of the cervix. The former is covered on its posterior surface by peritoneum, while its lateral and anterior surfaces are in contact with the connective tissue of the broad ligaments and bladder.

The infravaginal portion of the cervix, which is usually designated as the *portio vaginalis,* projects into the vaginal fornix, and at its tip presents a small transverse opening, the *external os,* bounded in front and behind by the so-called anterior and posterior lips of the cervix. Owing to the fact that the posterior fornix is deeper than the anterior, the posterior lip appears longer than the anterior.

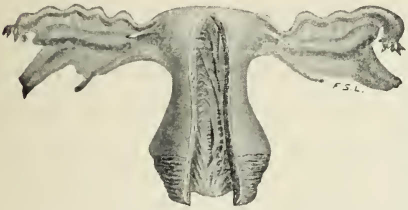

Fig. 40.—Uterus and Appendages of Young Child. × ⅔.

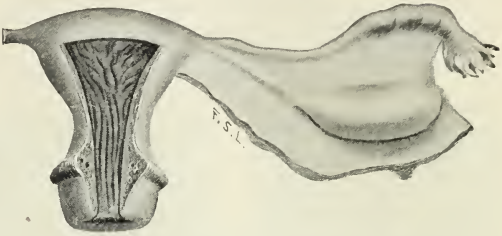

Fig. 41.—Uterus and Appendages of Fourteen-year-old Girl. × ⅔.

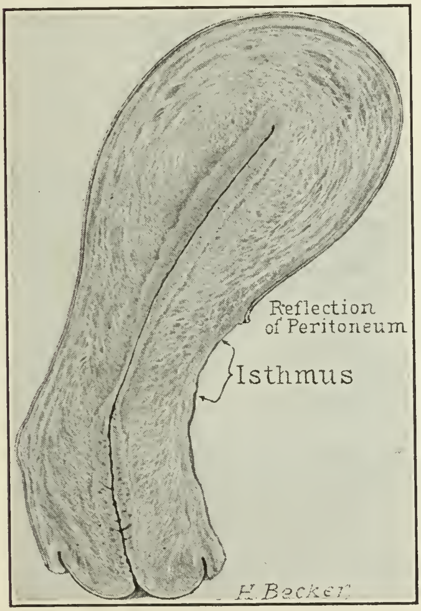

Fig. 42.—Sagittal Section of Normal Adult Uterus. × 1.

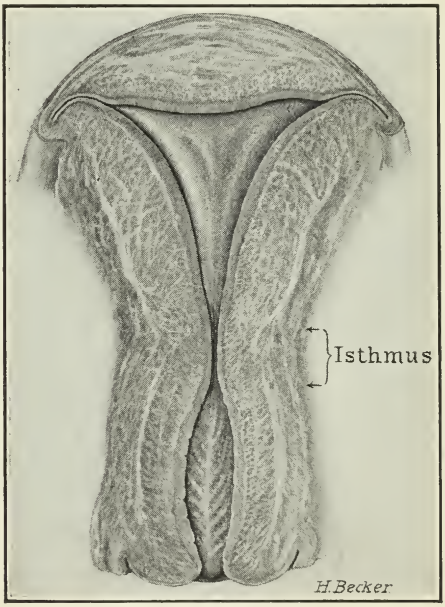

Fig. 43.—Frontal Section of Normal Adult Uterus,
Showing Shape of Cavity and Isthmus. × 1.

The external os may vary greatly in appearance. In the virgin it is a small, oval opening resembling a tench's mouth, whence the name, *os tincæ.* On vaginal examination it gives a sensation similar to that obtained on feeling the cartilage at the end of one's nose. After childbirth the orifice becomes converted into a transverse slit, and when the cervix has been deeply torn during labor it may present an irregular nodular or stellate appearance. These changes are very characteristic, and enable one to assert with tolerable accuracy whether a woman has borne children or not (Figs. 44 and 45).

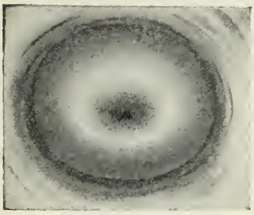

Fig. 44.—Virginal External Os.

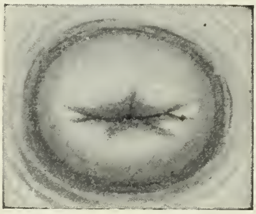

Fig. 45.—Parous External Os.

The cervix is composed of connective tissue in which are many nonstriated muscle fibers, many vessels and a certain amount of elastic tissue, a large part of its distensibility being due to the presence of the latter. The cervical canal, as has already been said, is fusiform in shape, and presents a longitudinal ridge upon its anterior and posterior surfaces, from which numerous others run off transversely, giving the membrane a corrugated appearance—the *arbor vitæ uterina* or *plicæ palmatæ*.

In the adult the arbor vitæ is limited to the cervical canal; but in childhood it extends throughout the entire cavity of the uterus, from which it begins to disappear as puberty is approached. In time, after repeated childbirth, it gradually becomes obliterated even in the cervical canal, whose walls become almost smooth.

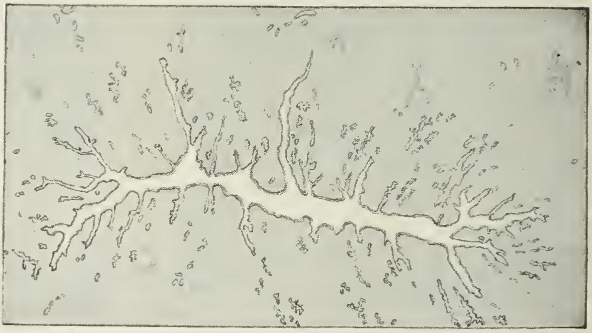

Fig. 46.—Cross-section through Cervical Canal. × 6.

The mucosa of the cervical canal, embryologically speaking, is a direct continuation of the lining of the uterine cavity, but has become differentiated from it and possesses a characteristic appearance, so that sections through the canal present a honeycomblike structure (Fig. 46). The mucosa is composed of a single layer of very high and narrow columnar epithelium, which rests upon a thin basement membrane. The oval nuclei are situated near the base of the columnar cells, the upper portions of which present a clear, more or less transparent appearance due to the presence of mucus. It is usually stated that these cells are abundantly supplied with cilia.

The cervical glands extend down from the surface of the mucosa into the stroma. They are of the branching, racemose variety, and are merely reduplications of the surface epithelium, being lined by epithelium of the same character.

Friedländer was the first to demonstrate that it was made up of true "beaker" or mucous cells, which furnish the thick, tenacious secretion of the cervical canal. There is no submucosa in the cervix, the mucosa resting directly upon the underlying tissue.

The mucosa covering the vaginal portion of the cervix is directly continuous with that of the vagina, and, like it, consists of many layers of stratified epithelium. Normally, there are no glands beneath it, but occasionally those from the cervical canal may extend down almost to its surface, and, if their ducts are occluded, may become converted into retention cysts, which shimmer through it and appear as rounded protuberances the size of small peas. These are the so-called nabothian follicles or *ovula Nabothi.*

Normally, the stratified epithelium of the vaginal portion and the cylindrical epithelium of the cervical canal meet abruptly at the external os. This, however, is the case only in early life, as in older persons the stratified epithelium gradually extends up the cervical canal until its lower third, and occasionally its lower half, is covered by it.

This change is more especially marked in multiparous women, in whom the lips of the cervix are not infrequently markedly everted; and occasionally, in cases of this character, almost the entire cervical canal may be lined by stratified epithelium.

In rare instances the junction of the two varieties of epithelium may be upon the vaginal portion, outside the external os. This condition was first described by Fischel, who designated it as *congenital ectropion,* and stated that he had observed it in 10 out of 28 uteri of young persons which he had examined. Still more rarely, in cases of imperforate hymen associated with hematokolpos the entire vaginal portion may be covered by cylindrical epithelium, which may extend down over the vaginal walls. This anomaly was first described by Ruge, who found the entire vagina and the inner surface of the hymen covered by a single layer of columnar, ciliated epithelium.

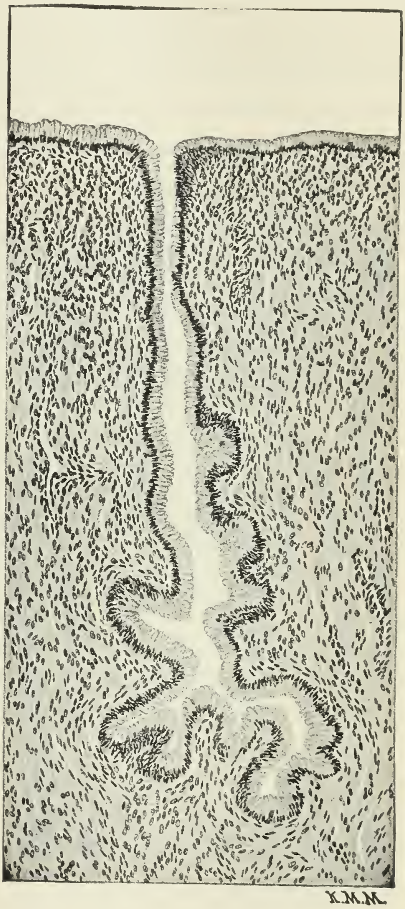

FIG. 47.—CERVICAL GLAND. × 90.

Corpus Uteri.—The wall of the uterine body is made up of three layers: serous, muscular, and mucous. The serous layer is formed bv the peritoneum covering the uterus, to which it is firmly adherent except at the margins, where it is deflected to the broad ligaments.

Endometrium.—The innermost or mucous layer, which serves as a lining for the uterine cavity, is commonly known as the endometrium. It is a thin, pinkish, velvety membrane, which on close examination is seen to be perforated by large numbers of minute openings—the mouths of the uterine glands. On account of the constant changes to which it is subject during the sexual life of woman, the endometrium varies greatly in thickness, and may measure anywhere from 0.5 to 3 or 5 millimeters without being necessarily abnormal. It consists of a surface epithelium, glands, and interglandular tissue, in which are found numerous blood vessels and lymphatic spaces.

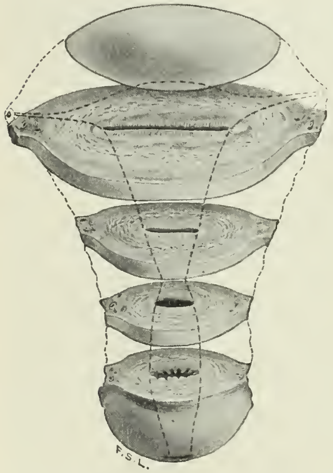

Fig. 48.—Reconstruction of Uterus, Showing Shape of Its Cavity and Cervical Canal. × 1.

As the endometrium does not possess a submucosa, it is attached directly to the underlying muscular layer in such a manner that its outer boundary presents irregularities in outline corresponding with the interstices between the muscle bundles. This arrangement is of considerable importance in connection with the operation of curettage; for, as Düvelius and Werth first showed, it is from the portions included between the muscle bundles that the endometrium is regenerated after that procedure.

The surface epithelium of the uterine mucosa is composed of a single layer of high columnar ciliated cells, which are closely packed together. The oval nuclei are situated in the lower portions of the cells, but not so near their bases as in the cervix. Beneath the epithelium is a thin basement membrane with narrow, spindle-shaped nuclei.

The existence of *cilia* was first demonstrated by Nylander in the sow, but they have since been found in all mammals. The researches of Meyer show that the time of their first appearance is variable, as they may be present at birth, but sometimes do not appear until much later. Hoehne and Mandl state that they are not present upon all cells, but that the ciliated cells occur in discrete patches, while the secretory activity appears to be limited to nonciliated cells. The cilia persist throughout the entire period of sexual activity, and, according to Parviainen, disappear eight or ten years after the menopause.

Up to 1893 it was generally taught that the current produced by them was directed from below upward—namely, from the cervix toward the fundus; but Hofmeier conclusively demonstrated that it is in the opposite direction, and his researches have since been generally confirmed. It may therefore be considered as a definitely established fact that the ciliary current in both the tubes and the uterus is in the same direction, and extends downward from the fimbriated end of the tubes to the external os.

In very exceptional instances the uterine cavity may be partially lined by stratified epithelium, as in the cases reported by Zeller and F. Friedländer. Such a condition readily explains the possible occurrence of flat-celled carcinoma of the body of the uterus.

Projecting down from the surface of the endometrium are large numbers of small tubular glands—the *uterine glands*. These must be regarded as invaginations of the surface epithelium and, in the resting state, resemble the fingers of a glove, though occasionally they branch slightly at their deeper extremities. They extend through the entire thickness of the endometrium to the muscular layer, which they occasionally penetrate for a short distance. They present the same histological structure as the surface epithelium, and are lined by a single layer of high, columnar, ciliated epithelium, which rests upon a thin basement membrane. They secrete small quantities of a thin, alkaline secretion, which serves to keep the uterine cavity moist.

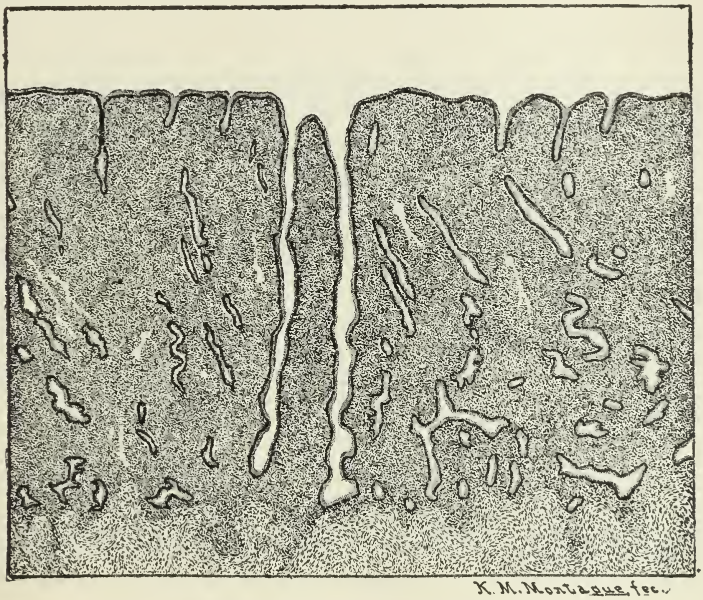

FIG. 49.—NORMAL RESTING ENDOMETRIUM. × 16.

Following the appearance of the monograph of Hitschmann and Adler, in 1908, much work has been done upon the anatomy of the endometrium, which was well reviewed by R. Schroeder, in 1915. The consensus of opinion now is that it is undergoing constant change during each menstrual cycle, and that four phases may be observed every 28 days: menstruation, regeneration, period of rest, and of premenstrual swelling. These changes will be considered in detail in the chapter upon menstruation, and here it will suffice to say that during the resting period the normal membrane is quite thin and contains relatively few tubular glands; while it increases rapidly in thickness during the period of premenstrual swelling, and then contains many convoluted or corkscrewlike glands.

In the child the uterine glands are mere shallow depressions, which, according to Kundrat and Engelman, do not appear until the third year; but the researches of Meyer, which are confirmed by my own experience, show that they are frequently present at birth. At the menopause the entire endometrium undergoes atrophic change; its epithelium becomes flatter, its glands gradually disappear, and its interglandular tissue takes on a more fibrous appearance (see Fig. 51).

The portion of the endometrium lying between the surface epithelium and the underlying muscle, which is not occupied by glands, is filled by an *interglandular* tissue or stroma of an embryonic type. In the resting stage, under the microscope (Figs. 49 and 52), it is seen to be made up of closely packed oval and spindle-shaped nuclei, around which there is very little protoplasm. When the tissues are spread apart by edema it is readily seen that the cells present a stellate appearance, with branching protoplasmic processes which anastomose one with another. The cells are more closely packed around the glands and blood vessels than elsewhere. On the other hand, during the premenstrual stage they become larger and more vesicular in character, and closely resemble decidual cells. Occasionally larger or smaller collections of round cells may be seen between them, though it is uncertain whether or not these are to be regarded as *lymphoid nodules*.

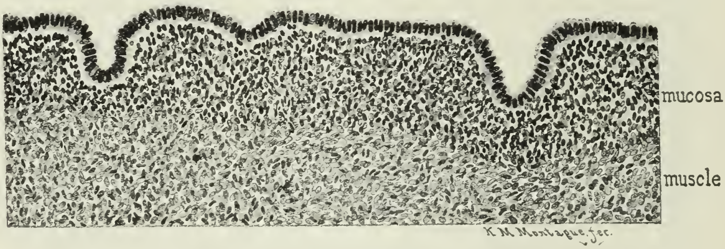

Fig. 50.—Endometrium of Newly Born Child. × 150.

The exact nature of the interglandular tissue has given rise to a great deal of discussion, concerning which the authorities are not yet fully agreed. Minot looked upon it as a form of embryonic tissue, while Nagel saw in it a resemblance to lymphoid tissue. On the other hand, Leopold, Championnière, Poirier, and others consider that it represents a lymphatic surface.

I agree with Minot that during the resting stage it should be considered as an embryonic type of connective tissue, which explains its various manifestations during the several phases of the sexual cycle. The correctness of such a view is indicated by the tissue-culture experiments of Traut, who has found that under such conditions only the stroma cells can be made to grow.

When preparations from the endometrium are treated by appropriate methods, an abundant reticulum can be demonstrated throughout its entire extent, which forms the scaffolding upon which it is constructed.

The endometrium contains many blood vessels. The arteries pursue a spiral course and break up into a capillary network just beneath the surface epithelium, from which the blood is returned by a few comparatively large vessels.

Musculature of the Uterus.—The major part of the uterus is made up of bundles of nonstriated muscle, which are united by a greater or lesser amount of connective tissue, in which are found many elastic fibers (Pick and Anspach). On section the nonpregnant uterine wall presents a thick, feltlike structure, in which definite layers cannot be distinguished.

A great deal of work has been done upon the arrangement of the musculature both of the pregnant and nonpregnant uterus. Tarnier and Ribemont-Dessaignes were unable to make out definite layers of muscle bundles in the nonpregnant organ, while Bayer, Kreitzer, Veit, and others distinguished several, but did not agree as to their arrangement. All admit, however, that the greater part of the uterine wall is made up of a mass of muscle which is perforated in all directions by blood vessels, and in which it is impossible to make out any definite arrangement of the bundles—*stratum vasculare*.

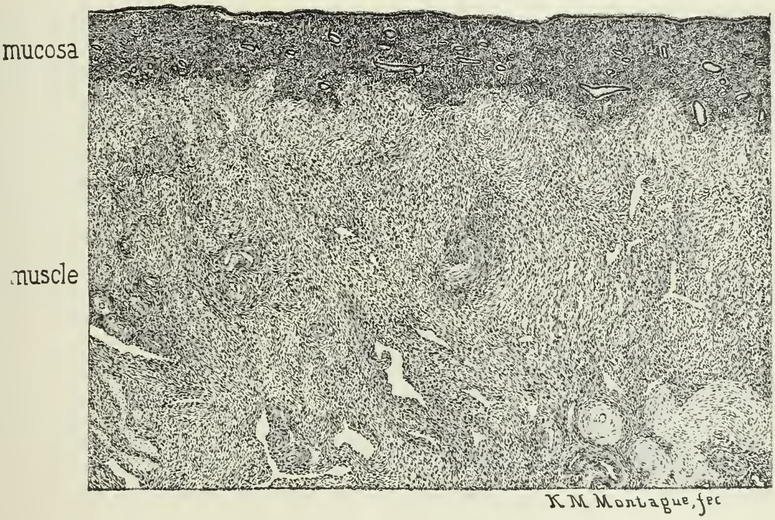

Fig. 51.—Senile Endometrium. × 16.

Roesger studied the question from a developmental point of view, and demonstrated that the muscle fibers are developed along the course of the blood vessels, but failed to distinguish any definite arrangement. Similar studies by Werth and Grusdew show that the musculature of the fœtal and infantile uterus presents a very simple arrangement, which becomes much more complicated as puberty is approached. During gestation, on the other hand, the uterus undergoes marked hypertrophy, when it becomes possible to distinguish certain distinct layers which will be considered in the chapter on the changes incident to pregnancy.

Under the name of the myometrial endocrine gland, Ancel and Bouin, in 1911, described in the rabbit peculiar collections of cells which appear between the muscular cells of the uterus about the middle of pregnancy. They held that they were of connective-tissue origin and probably possessed a definite internal secretory function. Fränkel was able to confirm their observations, but could not find similar structures in the human uterus. He was inclined to believe that they represented wandering fœtal cells, and was doubtful as to their secretory activity. Accordingly, the question must be regarded as *sub judice* until further investigations are available.

Ligaments of the Uterus.—Extending from either half of the uterus are three ligamentous structures—the broad, round, and uterosacral ligaments (ligamenta lata, teretia, and uterosacralia).

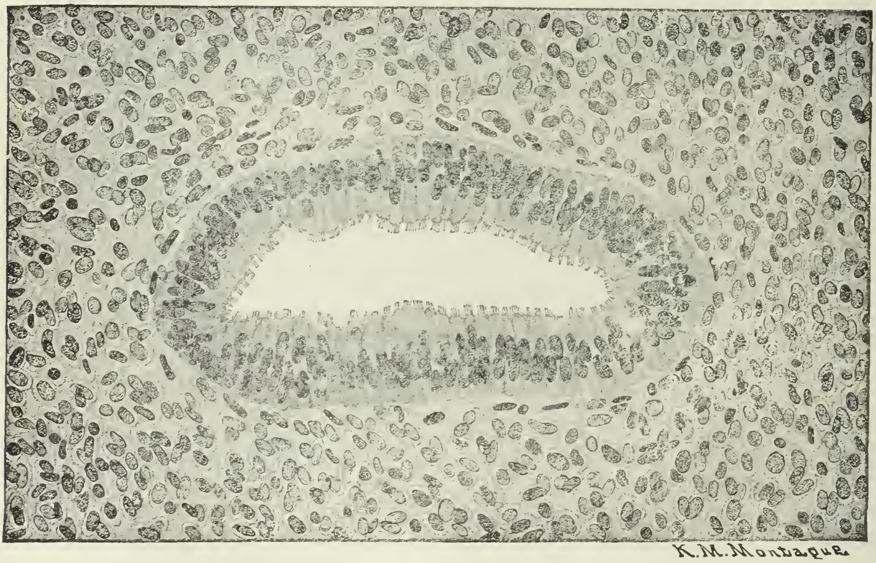

Fig. 52.—Gland and Stroma of Resting Endometrium. × 420.

The broad ligaments, or *ligamenta lata,* are two winglike structures which extend from the lateral margins of the uterus to the pelvic walls, and serve to divide the pelvic cavity into an anterior and a posterior compartment. Each broad ligament consists of a fold of peritoneum inclosing various structures within it, and presents four margins for examination—a superior, lateral, inferior, and median. The superior margin, for its inner two thirds, is occupied by the fallopian tube, while its outer third, extending from the fimbriated end of the tube to the pelvic wall, is known as the *infundibulopelvic ligament*—the suspensory ligament of the ovary (Henle)—and serves to transmit the ovarian vessels. The portion of the broad ligament beneath the fallopian tube is called the *mesosalpinx,* and consists of two layers of peritoneum which are united by a small amount of loose connective tissue, in which is embedded the *parovarium* or organ of Rosenmüller.

The parovarium consists of a number of narrow vertical tubules, lined with ciliated epithelium, which connect by their upper ends with a longitudinal duct, which extends just below the tube to the lateral margin of the uterus, in whose muscular wall it ends blindly at about the region of the internal os. This canal is the remnant of the wolffian duct, and in the female is designated as Gartner's duct. The parovarium corresponds to the epididymis and is usually considered as the remains of the wolffian body. Waldeyer, in 1870, however, showed that it represents only the cranial portion of the latter, and designated it as the epoöphoron, and suggested the term paroöphoron for its caudal portion.

The latter is the analogue of the organ of Giraldès, and according to Rieländer is situated near the free end of the broad ligament between the terminal branches of the ovarian artery just before they enter the ovary. The paroöphoron consists of a small number of slightly convoluted tubules, lined by the nonciliated epithelium. The organ tends to disappear with advancing years; and is of interest only from the fact that it occasionally gives rise to tumor formations.

Hofbauer, in 1926, showed that in the connective tissue at the sides of the uterus, as well as at the base of the broad ligament, there are always a certain number of clasmatocytes. In the presence of infection or of other irritation they increase greatly in number and serve to engulf bacteria, so that he has designated it as a defensive mechanism. In our experience, it plays an important part in arresting or limiting infections, especially when they originate from lesions about the cervix.

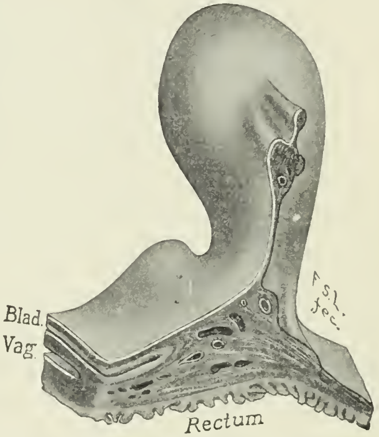

FIG. 53.—SECTION THROUGH UTERINE END OF BROAD LIGAMENT. × ⅔.

At the lateral margin of the broad ligament, the peritoneal covering is reflected upon the side of the pelvis. The inferior margin, which is quite thick, is continuous with the connective tissue of the pelvic floor. Through it pass the uterine vessels. Its lower portion—the cardinal ligament of Kocks, the *ligamentum transversale colli* of Mackenrodt, or the *retinaculum uteri* of Martin—is composed of dense connective tissue which is firmly united to the supravaginal portion of the cervix. The median margin is connected with the lateral margin of the uterus, and incloses the uterine vessels; through it certain muscular and connective-tissue bands extend from the uterus into the broad ligament.

A vertical section through the uterine end of the broad ligament is triangular in shape, with the apex directed upward, while its base is broad and contains the uterine vessels; it is widely connected with the connective tissue of the pelvic floor, which is designated as the *parametrium*. A vertical section through the middle portion of the broad ligament shows that its upper part is made up mainly of three branches in which the tube, ovary, and round ligament are situated, while its lower portion is not so thick as in the previous section.

The *round ligaments,* or *ligamenta teretia,* extend on either side from the anterior and lateral portion of the uterus, just below the insertion of the tubes. Each lies in a fold of the broad ligament and runs in an upward and outward direction to the inguinal canal, through which it passes, to terminate finally in the upper portion of the labium majus. The round ligament varies from 3 to 5 millimeters in diameter; it is composed of nonstriated muscle, which is directly continuous with that of the uterine wall, and a certain amount of connective tissue. In the nonpregnant condition it appears as a lax cord, but in pregnancy it undergoes considerable hypertrophy and seems to act as a stay for the uterus. It can be palpated during pregnancy, and by its varying position aids one in diagnosing the location of the placenta.

The *uterosacral ligaments—retractores uteri* (Luschka)—are two structures which extend from the posterior and upper portion of the cervix, encircle the rectum, and are inserted into the fascia covering the second and third sacral vertebræ. They are likewise composed of connective tissue and muscle, and are covered by peritoneum. They form the lateral boundaries of Douglas's culdesac, and are believed to play a part in retaining the uterus in its normal position by exerting traction upon the cervix.

Position of the Uterus.—After many years of discussion, anatomists and gynecologists have agreed that the normal position of the uterus is one of slight anteflexion, and that the nonpregnant organ lies deeper in the pelvic cavity than is usually realized. With the woman standing upright, it occupies an almost horizontal position and is somewhat bent upon its vesical surface, the fundus resting upon the bladder, while the cervix is directed backward toward the tip of the sacrum, with the external os about on the level of the ischial spines (see Fig. 23). The position of the organ varies markedly according to the degree of distention of the bladder and rectum, but when these are empty the uterus always tends to resume its normal position.

The causes which bring about its anteflexed position have not as yet been definitely determined. Normally, as long as it is in situ, the organ is anteflexed, but when removed from the body it immediately straightens out. Schauta would attribute the anteflexion to the action exerted by the vessels when filled with blood, but his explanation does not appear altogether satisfactory. According to Nagel and most embryologists, the anteflexion exists from the earliest stages of development, and is to be acounted for by the fact that the entire body is developed along a curved line.

The uterine ligaments were formerly supposed to play an important part in maintaining the uterus in its characteristic position. We have already indicated the functions of the round and uterosacral ligaments. The upper portion of the broad ligament appears to have no influence upon the position of the uterus,

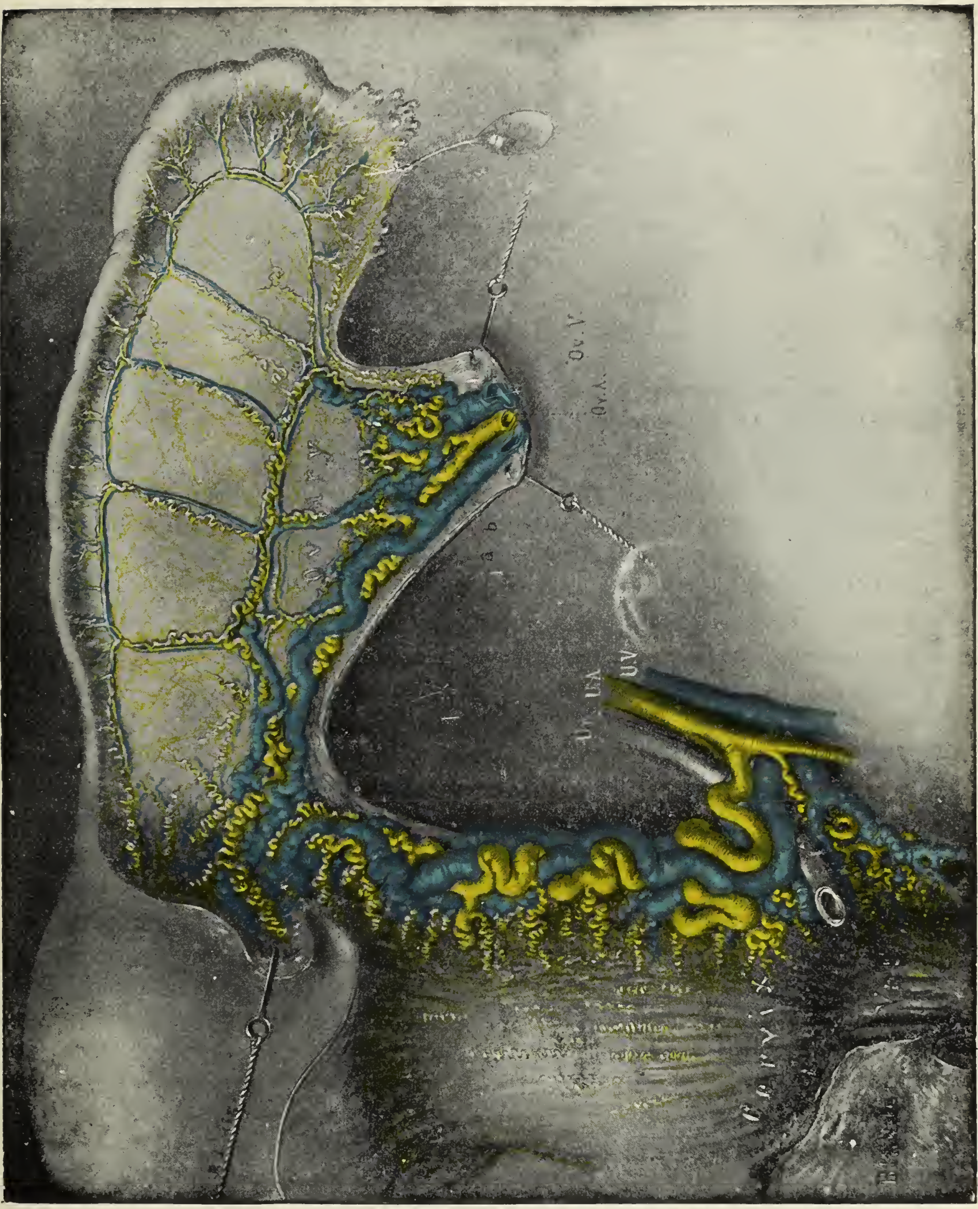

Fig. 54.—Blood Supply of Uterus (Kelly).

since Mackenrodt has demonstrated that it can be cut through without causing any change in position, which occurs only when its deeper portion—the ligamentum transversale colli—is divided.

Blood Vessels of the Uterus.—The vascular supply of the uterus is derived from two sources: principally from the uterine, and to a lesser extent from the ovarian, arteries. The uterine artery is the main branch of the hypogastric, which, after descending for a short distance, enters the base of the broad ligament, crosses the ureter, and makes its way to the side of the uterus. Just before reaching the supravaginal portion of the cervix, it divides into two branches, the smaller—the cervicovaginal artery—supplying the lower portion of the cervix and the upper portion of the vagina. The main branch turns abruptly upward and extends as a very convoluted vessel along the margin of the uterus, giving off a branch of considerable size to the upper portion of the cervix, and numerous smaller ones, which penetrate the body of the uterus. Just before reaching the tube it divides into three terminal branches—the fundal, tubal, and ovarian —the last of which anastomoses with the terminal branch of the ovarian artery; the second, making its way through the mesosalpinx, supplies the tube, while the fundal branch is distributed to the upper portion of the uterus.

The ovarian or internal spermatic artery is a branch of the aorta and enters the broad ligament through the infundibulopelvic ligament. On reaching the hilum of the ovary it breaks up into a number of small branches which enter that organ, while its main stem traverses the entire length of the broad ligament and makes its way to the upper portion of the margin of the uterus, where it anastomoses with the ovarian branch of the uterine artery. For further particulars concerning the vascular supply the student is referred to the comprehensive monographs of Freund, Farabeuf, and Kownatski.

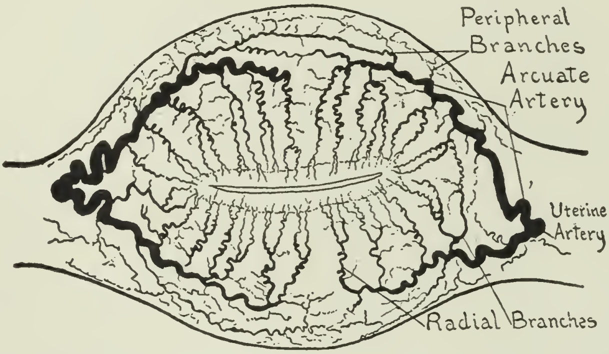

Fig. 55.—Radiograph of Thin Cross-section of Uterus, Showing Arterial System (Sampson).

It is generally stated that there is very little communication between the vessels on the two sides of the uterus, but the experiments of Clark have demonstrated that such is not the case. This observer found that when the uterine artery on one side was injected the fluid escaped from the opposite uterine artery before it began to flow from the veins, thus indicating the presence of numerous arterial anastomoses in the substance of the uterus. Figure 55 affords additional evidence of this fact, and shows how the radial branches of the arcuate arteries extend from the outer portion of the uterine wall to supply the endometrium.

The veins of the uterus are very abundant and pursue a course the reverse of that of the arteries. When the uterus is contracted their lumina are collapsed, but in injected specimens the greater part of the uterine wall appears to be composed of venous sinuses as was pointed out by Sampson. The arcuate veins unite to form the uterine vein on either side, which then empties into the hypogastric vein, which makes its way into the internal iliac. The blood from the ovary and upper part of the broad ligament is collected by a number of veins, which form a large plexus within the broad ligament—the *pampiniform plexus* —the vessels from which terminate in the ovarian vein. The right ovarian vein empties into the vena cava, while the left empties into the renal vein.

Lymphatics.—The careful work of Leopold, Poirier, Bruhns, and others has given us a fairly definite idea of the lymphatic system of the uterus. The endometrium is abundantly supplied with lymph spaces, but possesses no true lymphatic vessels. Immediately beneath it in the muscularis a few lymphatics may be found, which become better defined as the peritoneum is approached, and form an abundant lymphatic plexus just beneath it, especially on the posterior wall of the uterus.

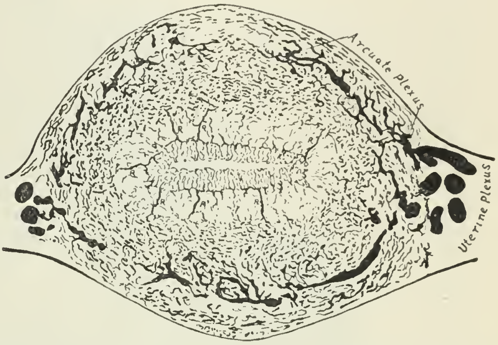

Fig. 56.—Radiograph of Thin Cross-section of Uterus Showing Venous System (Sampson).

The lymphatics from the various portions of the uterus are connected with several sets of glands—those of the cervix terminating in the hypogastric glands, which are situated in the spaces between the external iliac and hypogastric arteries. The lymphatics from the body of the uterus are distributed to two groups of glands, one set of vessels making their way to the hypogastric glands, while another set, after joining certain lymphatics from the ovarian region, terminate in the lumbar glands, which, in turn, are situated in front of the aorta at about the level of the lower portion of the kidneys (see Fig. 57).

Innervation.—The uterus possesses an abundant nerve supply, whose function, however, appears to be regulatory rather than primary. This is shown by the fact that in experimental animals labor can progress satisfactorily after all nerves going to the uterus have been severed, but especially by the fact that the human uterus, from the latter part of intra-uterine life until after the menopause, will contract rhythmically for hours after excision if immersed in warm Locke's solution and plentifully supplied with oxygen.

The nerve supply is derived principally from the sympathetic nervous system, but partly from the cerebrospinal and parasympathetic system. Although first described in the eighteenth century by Walter and Haller, it was particularly studied by Lee and Frankenhäuser, as well as by many later investigators, among whom Dahl and J. Novak may be mentioned.

The parasympathetic or autonomic system is represented on either side by the pelvic nerve, which consists of a few fibers derived from the second, third and fourth sacral nerves, and loses itself in the ganglion of Frankenhäuser. The sympathetic system gains access to the pelvis by means of the hypogastric plexus, which arises from the forking of the aortic plexus just below the promontory of the sacrum, and after descending on either side loses itself in the Frankenhäuser plexus. The latter consists of ganglia of varying size, but particularly of a large ganglionic plate situated on either side of the cervix just above the posterior fornix and in front of the rectum. In their excellent gross anatomical study, Latarjet and Rochet state that in reality Frankenhäuser's ganglion lies posterior to the cervix and occupies the base of the uterosacral ligament.

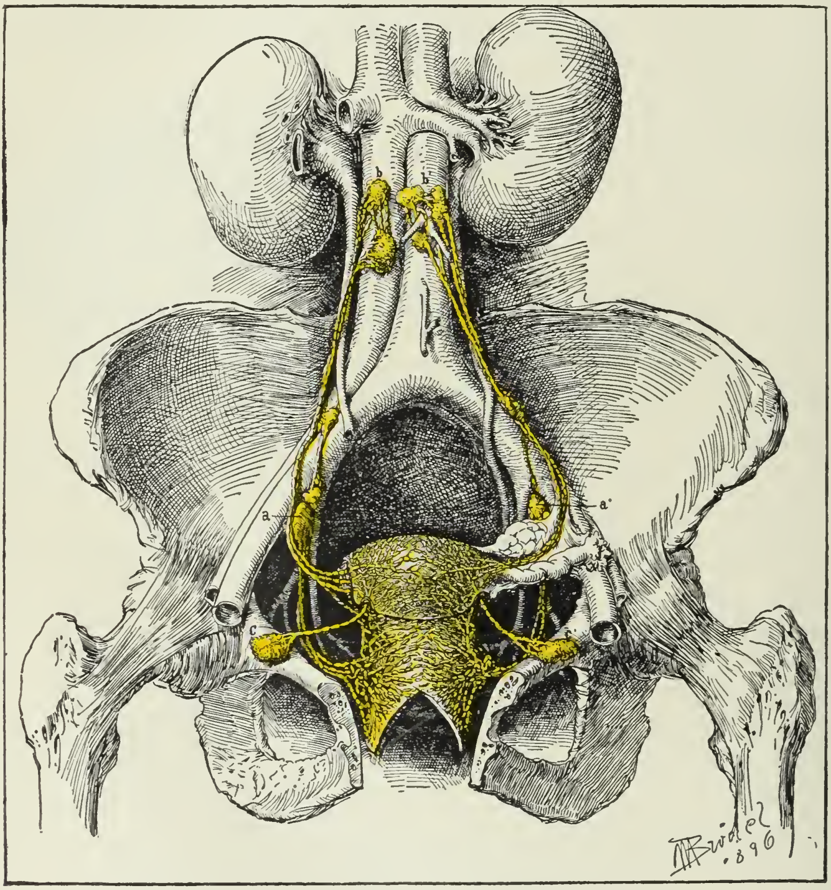

Fig. 57.—Lymphatics of Uterus (Kelly).

Branches from these plexuses supply the uterus, bladder and upper part of the vagina, and are made up of both medullated and nonmedullated fibers. Some of them terminate by free endings between the muscle fibers, while others make their way toward the free surface of the endometrium. It has not yet been determined whether or not ganglionic cells are present in the walls of the uterus or tubes.

Both the sympathetic and parasympathetic nerve supplies contain motor and a few sensory fibers, whose functions are in great part antagonistic; the former causing muscular contraction and vasoconstriction, while the latter inhibits contraction and leads to vasodilatation. As the Frankenhäuser plexus is derived from both sources it is apparent that it must partake of the properties of both types of nerves.

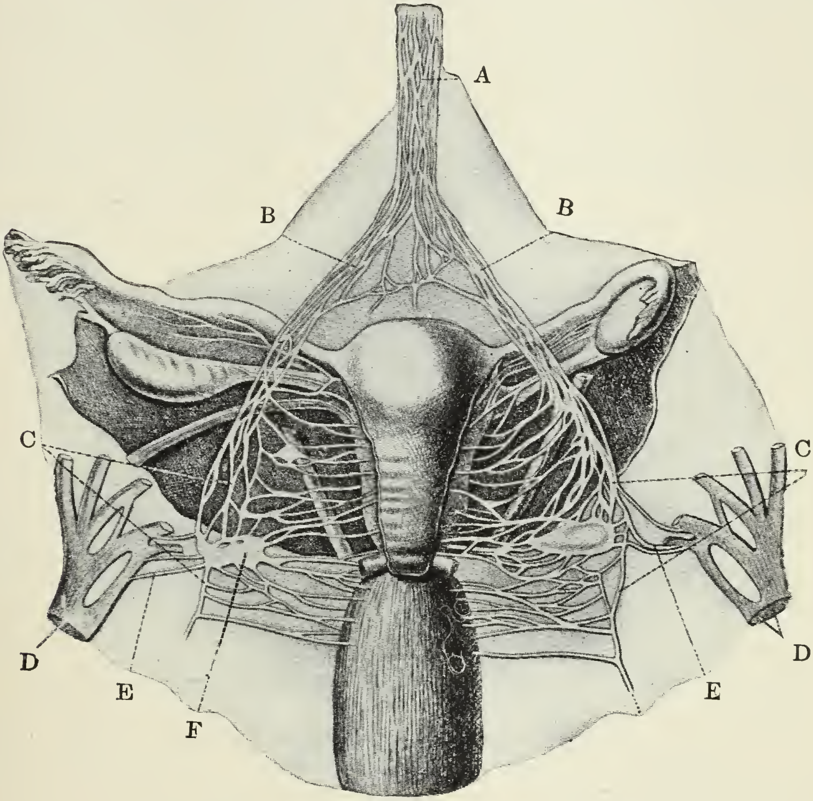

Fig. 58.—Nerve Supply of Pelvic Organs (Dahl).
A, plexus aorticus; *B,* plexus hypogastricus; *C,* Frankenhäuser plexus; *D,* plexus pudendus et sacralis; *E,* nervus erigens; *F,* ganglion.

Since 1926, the nerve supply of the genitalia has assumed a definitely practical interest, as Segond, Cotte and others claim that various painful pelvic affections may be permanently relieved by severing the hypogastric plexus, which they designate as the *nerf presacré.*

Development of the Uterus.—It is universally admitted by embryologists that both the tubes and the uterus are derived from the müllerian ducts. According to His, the first signs of their development can be noted in embryos having a body length of from 7 to 7.5 millimeters, when a thickening may be noticed in the cœlomic epithelium on the outer margin of each wolffian body. These gradually become converted into two epithelial ducts, which converge and eventually meet together in the middle line, terminating in the urogenital sinus.

The müllerian ducts reach the urogenital sinus in embryos having a body length of 2.5 to 3.5 centimeters. Their upper ends form the fallopian tubes, while their lower portions fuse together to form the uterus and vagina. The fusion of the müllerian ducts is usually completed at about the third month, though the point at which the process is to occur is indicated at a much earlier period by the position of the round ligaments.

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THE FALLOPIAN TUBES

The fallopian or uterine tubes are more or less convoluted muscular canals which extend from the uterine cornua to the ovaries, and represent the excretory ducts of the latter, as it is through them that ova gain access to the uterine cavity. They are more or less cylindrical in shape, vary from 8 to 14 centimeters in length, are covered by peritoneum, and possess a lumen lined by mucous membrane.

For convenience in description, each tube may be divided into the uterine portion, isthmus, ampulla, and infundibulum. The uterine portion is included within the muscular wall of the uterus, and extends from the cornu to the upper angle of the uterine cavity. Its lumen is so small that it will admit only the finest probe. The *isthmus* is the narrow portion of the tube immediately adjoining the uterus, and gradually passes into the wider lateral portion or *ampulla*. The *infundibulum,* or fimbriated extremity, is the funnel-shaped opening of the lateral end of the tube, the margins of which present a dentate appearance (see Fig. 63).

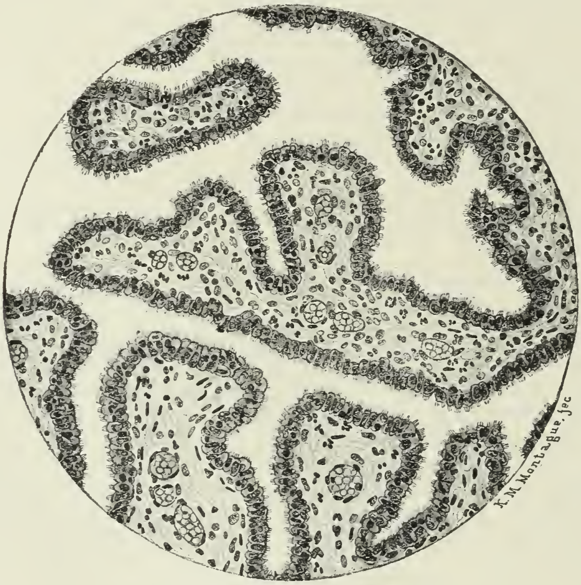

Fig. 59.—Tubal Mucosa. × 280.

The tube varies considerably in thickness, the narrowest portion of the isthmus measuring from 2 to 3 millimeters, and the widest portion of the ampulla from 5 to 8 millimeters in diameter.

With the exception of its uterine portion, the tube, throughout its entire length, is included within the upper margin of the broad ligament; it is completely surrounded by peritoneum except at its lower portion, corresponding to

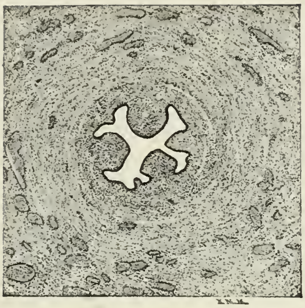

FIG. 60.

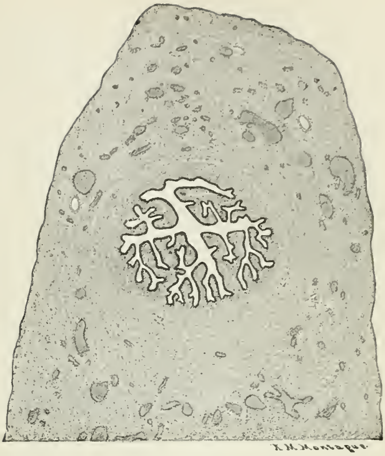
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FIG. 61.

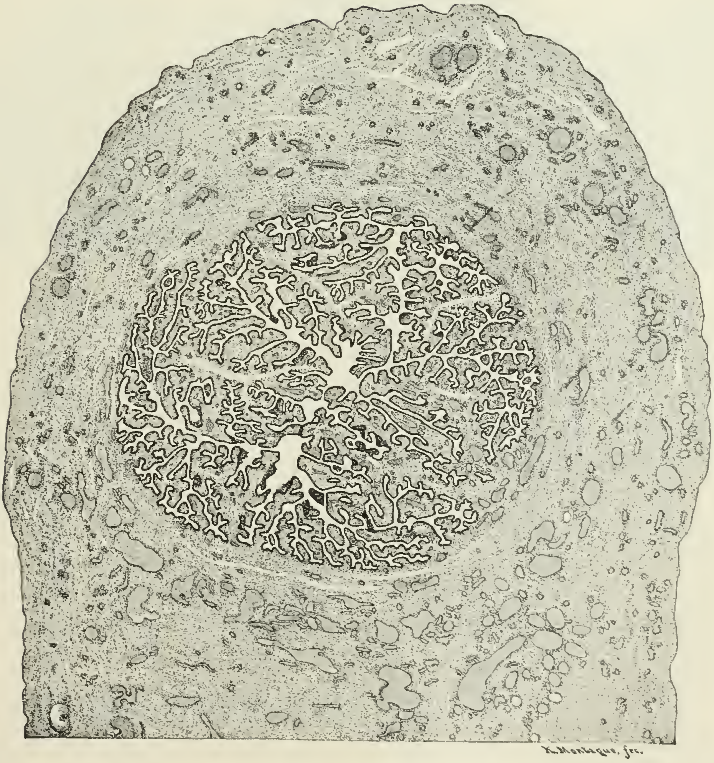
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FIG. 62.

FIGS. 60-62.—SECTIONS THROUGH UTERINE, ISTHMIC, AND AMPULLAR PORTIONS OF TUBE. × 15.

the mesosalpinx. The fimbriated extremity opens freely into the abdominal cavity, and one of its fimbriæ—the *fimbria ovarica*—which is considerably longer than the others, forms a shallow gutter which extends almost or quite to the ovary.

Generally speaking, the musculature of the tube is arranged in two layers—an inner, circular, and an outer, longitudinal layer. In its uterine portion a third layer, lying between the circular layer and the mucosa, and composed of longitudinal fibers, may be distinguished. In the lateral portion of the tube the two primary layers become less marked, and in the neighborhood of the fimbriated extremity are replaced by an interlacing network of muscle fibers. The writer was the first to call attention to the presence of the inner longitudinal layer, and his observations have been generally confirmed. Seckinger and Snyder, in 1926, showed that the tubal musculature is constantly undergoing rhythmic contractions, whose rate varies with several phases of the sexual cycle. The contractions occur with greatest frequency and intensity at the time when ova are descending the tube, and are slowest and weakest during pregnancy.

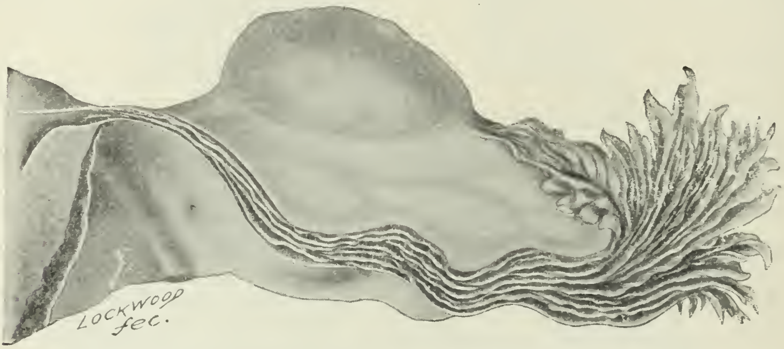

Fig. 63.—Longitudinal Folds of Tubal Mucosa (Sappey).

The lumen of the tube is lined with a mucous membrane whose epithelium is composed of a single layer of high columnar cells, which rest upon a thin basement membrane (Fig. 59). According to Snyder, Novak and Everett, and others, only a portion of the cells are ciliated. These are arranged in discrete patches, while the nonciliated cells are supposed to be secretory. Grosser, on the other hand, contends that the great majority are ciliated. There is no submucosa, the epithelium being separated from the underlying muscle by a layer of connective tissue of varying thickness.

The mucosa is arranged in longitudinal folds which become more complicated as the fimbriated end is approached. Consequently, the appearance of the lumen varies according to the portion of the tube examined. In cross sections through the uterine portion four simple folds are seen, which together make a figure resembling a Maltese cross. In the isthmic portion a more complicated appearance can be noted; while in the ampulla the lumen is almost completely occupied by the arborescent mucosa, which upon careful examination is seen to be made up of four very complicated treelike folds (Fig. 63).

The statements of Hennig and the early investigators that the tube possesses glands have since been found to be erroneous, inasmuch as the structures, which they considered as such, are merely depressions between folds of the mucosa. This was conclusively demonstrated by Frommel, who showed that the glandular appearance disappeared upon distending the tube, when the greater part of its lumen became perfectly smooth, with four arborescent folds of mucosa arising from its sides. It is interesting to note that Nature sometimes performs a similar experiment in cases of hydrosalpinx.

The current produced by the cilia of the tube is directed from the fimbriated extremity toward the uterus, as was first demonstrated by the experiments of Pinner, Jani, and Lode, who showed that minute foreign bodies introduced into the abdominal cavity of animals eventually appeared in the vagina, after making their way down the lumen of the tubes and the cavity of the uterus.

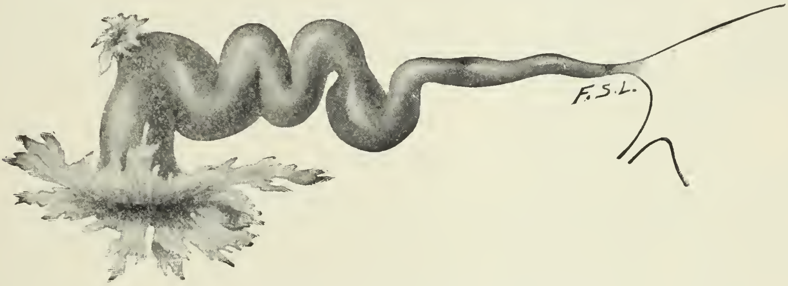

Fig. 64.—Tube with Accessory Ostium.

Contrary to the teaching of many that peristaltic muscular contraction is the main factor concerned in the downward passage of the ovum, Grosser contends that the ciliary current plays the principal part.

The tubes are richly supplied with elastic tissue, blood vessels and lymphatics, and the latter sometimes become so dilated as to fill up almost entirely certain folds of the mucosa.

Occasionally, as Richard first pointed out, the tube may possess a second fimbriated extremity, which is known as an accessory ostium (Fig. 64). Again, small tubelike structures, with miniature fimbriated extremities, frequently project from the exterior of the tube. As a rule, these are mere culsdesac, but occasionally one is met with possessing a lumen which communicates with that of the main tube. In several instances, extra-uterine pregnancy has followed the arrest of the fertilized ovum in such a structure.

Similar formations are frequently observed upon the anterior surface of the mesosalpinx, but have no connection with the tube. They have been studied more particularly by Kossmann, who designated them as *accessory tubes*. They are probably derived from aberrant portions of the cœlomic epithelium.

In very exceptional instances there may be two tubes on one side, Bab having reported two cases of his own, together with five others collected from the literature.

Diverticula may occasionally extend from the lumen of the tube for a variable distance into its muscular wall, and reach almost to its peritoneal covering. Such structures were first described by Landau and Rheinstein, and myself. The suggestion that they might play a part in the production of tubal pregnancy would seem plausible, inasmuch as a fertilized ovum, which might chance to make its way into such a diverticulum, would be arrested at its end and there develop, if suitable conditions existed.

In rare instances the main canal of the tube may branch, and two or even three lumina may be seen in sections. After extending for a certain distance, more or less parallel to the main lumen, they usually rejoin it. It should always be borne in mind that such appearances are frequently due to the fact that two or more twists or bends of the tube have been included in one section.

In the new-born child the tubes are markedly convoluted, and present a corkscrewlike appearance, as shown in Fig. 40. This gradually disappears with age, but occasionally the fœtal condition persists and may play a not unimportant part in the causation of sterility and tubal disease, as was first pointed out by Freund and Schober.

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THE OVARIES

General Anatomy.—The ovaries are two flattened, more or less almond-shaped organs, whose chief functions are the development and extrusion ot ova, and the elaboration of an internal secretion. They may vary considerably in size, and during the childbearing period measure from 2.5 to 5 centimeters in length, 1.5 to 3 centimeters in breadth, and 0.6 to 1.5 centimeter in thickness. After the menopause they diminish markedly in size, and in old women are often scarcely larger than peas.

Normally, the ovaries are situated in the upper part of the pelvic cavity, one surface of each ovary resting in a slight depression in the upper portion of the inner surface of the obturator muscle—the *fossa ovarica* of Waldeyer. With the woman standing, the long axes of the ovaries occupy an almost vertical position, which become horizontal when she is on her back. Their situation, however, is subject to marked variations, and it is rare to find both ovaries at exactly the same level.

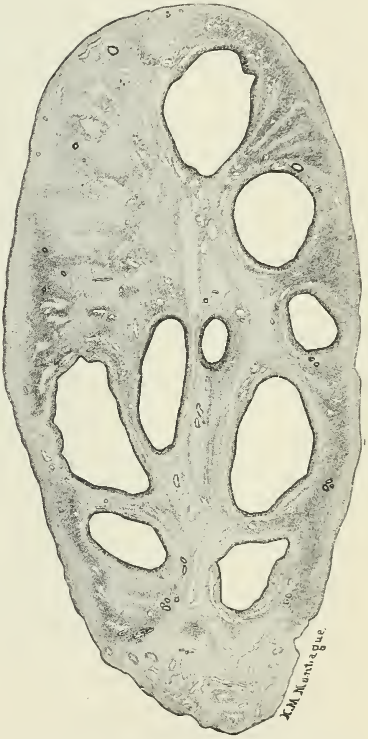

Fig. 65.—Cross-section of Adult Ovary. × 4.

Each ovary presents for examination two surfaces, two margins, and two poles. The surface which is in contact with the ovarian fossa is called the lateral, and the one directed toward the uterus is known as the median surface. The margin which is attached to the mesovarium is more or less straight, and is designated as the hilum, while the free margin is convex and is directed backward and inward toward the rectum. The extremities of the ovary are termed the upper and lower, or tubal and uterine poles respectively.

The ovary is attached to the broad ligament by the *mesovarium,* which forms the posterior leaf of that structure. The *ovarian ligament* extends from the lateral and posterior portion of the uterus, just beneath the tubal insertion, to the uterine or lower pole of the ovary. It is usually several centimeters long and 3 to 4 millimeters in diameter. It is covered by peritoneum, and is made up of muscle and connective-tissue fibers, which are continuous with those of the uterus. The *infundibulopelvic* or *suspensory ligament* of the ovary extends from its upper or tubal pole to the pelvic wall. It represents the portion of the upper margin of the broad ligament which is not occupied by the tube, and through it the ovarian vessels and nerves gain access to the broad ligament.

For the most part the ovary projects freely into the abdominal cavity, and is not covered by peritoneum except near its hilum, where a narrow band may be observed which is continuous with the peritoneum covering the mesosalpinx. It follows, therefore, that over its lower portion only can be noted the glistening appearance characteristic of peritoneum, while the greater part of its surface is of a dull white color and looks moist. This distinction was discovered by Farre, but its importance was first emphasized by Waldeyer (Fig. 71), who showed that the ovary above the peritoneal line is covered by cuboidal epithelium.

In many of the lower animals, as in the rat, the ovary does not project freely into the abdominal cavity, but is inclosed in a peritoneal sac, into which opens the fimbriated end of the tube. In the cow, dog, and cat there is more or less free communication between the former and the peritoneal cavity.

The exterior of the ovary varies in appearance according to the age of the individual. In young women the organ presents a smooth, dull white surface, through which glisten a number of small, clear vesicles—the graafian follicles. As the woman grows older it takes on a more corrugated appearance, which in the aged may become so marked as to be suggestive of the convolutions of the brain.

The general structure of the ovary can best be studied in cross sections, when the organ is seen to be made up of two portions: the cortex and medulla, or zona parenchymatosa and zona vasculosa. The *cortex* or outer layer varies in thickness according to the age of the individual, becoming thinner with advancing years. In this layer the ova and graafian follicles are situated. It is composed of spindle-shaped connective-tissue cells, through which are scattered primordial and graafian follicles in various stages of development, which become less numerous as the woman grows older. The most external portion of the cortex presents a dull whitish appearance, and is designated as the *albuginea,* though it is not analogous with the similarly named structure in the testicle; on its surface is a single layer of cuboidal epithelium—the ovarian epithelium of Waldeyer.

The *medulla* or central portion of the ovary is composed of loose connective tissue, which is continuous with that of the mesovarium. It contains large numbers of blood vessels, both arteries and veins; and, according to His, Kölliker, and Rouget, a considerable number of nonstriated muscle fibers, whose presence caused the last-named observer to class it among the erectile tissues. The arrangement of the blood vessels has been studied exhaustively by Clark, to whose admirable monograph we would refer those interested in the subject.

In the neighborhood of the hilum one frequently observes short ducts or tubes, which are lined by a single layer of columnar epithelium. Their significance is not clear, and it is difficult to determine whether they represent remnants of the rete ovarii or of the wolffian bodies.

In the human fœtus collections of epithelial cells are frequently observed in the neighborhood of the hilum, which are arranged in masses or strands sharply marked off from the surrounding stroma. These are the medullary cords of Kölliker, who believed that they represented portions of the wolffian body which had become included within the ovary. The investigations of Winiwarter, Wilson, and other authorities have shown, however, that these cells represent the remains of the first proliferation of the germinal epithelium, and are analogous to the seminiferous tubules of the testicle. In early embryos the lower extremities of the medullary cords develop lumina which eventually communicate with the tubules of the epoöphoron (rete ovarii) (Fig. 70). In the female this is only a transient phenomenon, and usually disappears before birth; but in the male it persists and affords a satisfactory explanation for the employment of the wolffian ducts as the efferent channels for the testicles. On

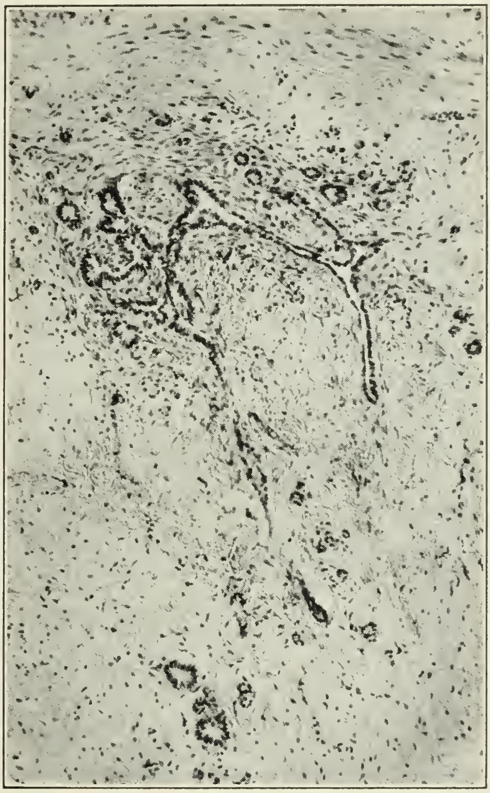

Fig. 66.—Wolffian Body Tubules in Hilum of Ovary. × 140.

the other hand, the medullary cords are persistent and characteristic structures in many of the lower animals.

Moreover, in many of the lower animals the medulla of the ovary is occupied to variable extent by masses of characteristic epithelioid cells, somewhat resembling those making up the corpus luteum. Limon, in 1901, called attention to their existence, and his findings were confirmed by Aimé, and others. The origin of the cells is not clear, but, as they are supposed to take part in the formation of an internal secretion, they are sometimes designated as the interstitial gland of the ovary. Strictly speaking, no such gland exists in women, and great confusion would have been avoided had many writers, who had no conception of the histological structure of the ovary, not allowed their imagination to run riot; as has happened in the case of Lipschütz, in whose monograph it is described as the "puberty gland," and every occurrence in the sexual life of women, except fertilization, is attributed to it.

The researches of L. Fränkel, Schaeffer, and Meyer confirm this view. On the other hand, Wallart, Aschner, and Seitz have applied the term to the hypertrophic theca cells which develop about the periphery of follicles which are undergoing atresia, and I can confirm the statement of Aschner that such "interstitial glands" are rarely present in the nonpregnant adult woman, but are well marked before puberty and during pregnancy. They believe that these transient structures give rise to an internal secretion, and thus play an important part in the economy of the individual.

Kraul has shown that both sympathetic and parasympathetic nerves supply the ovaries, and that their coördination is essential to perfect functioning. The sympathetic nerves are derived in great part from the plexus which accompanies the ovarian vessels—the so-called ovarian plexus—while a few are derived from the plexus surrounding the ovarian branch of the uterine artery. Their finer anatomy, after they enter the ovary, has been studied by numerous investigators, among whom may be mentioned von Herff, Abel and McIlroy, and Wallart. The consensus of these researches is that the ovary is very richly supplied with nonmedullated nerve fibers, which for the most part accompany the blood vessels, and are merely vascular nerves; whereas others form wreaths around normal and atretic follicles and give off many minute branches, which have been traced up to, but not through, the membrana granulosa. Dahl was unable to find collections of ganglionic cells in the medulla, such as have been described by other investigators.

Accessory Ovaries.—Waldeyer, in 1870, directed attention to the occasional presence of accessory bodies which are sometimes found on the broad ligament in the neighborhood of the main ovary. These structures are usually small, although in rare instances they may attain a considerable size. Occasionally they result from faulty development, but more frequently are to be attributed to inflammatory changes occurring during fœtal life, as a consequence of which small portions of the ovary have been cut off from the body of the organ. The subject has been considered in detail by Engström, Thumin, Seitz, and Chiari, and cases have been described in which there was found a typical third ovary connected with the uterus by a separate tube.

Transplantation of Ovaries.—Experimental studies undertaken by Grigorieff, Knauer, Marshall, Steinach, and others have shown that the ovaries of animals and women can be excised from their original position and transplanted to other portions of the body, or even into other animals of the same species, and that in their new situation they can establish vascular connections and continue their functional activity. Pregnancy has repeatedly followed such operations in animals. For full literature upon the subject up to 1922 the reader is referred to the article of F. H. Martin, in which it is stated that the results in women have been disappointing, and that while satisfactory results sometimes follow autotransplantation, there is little evidence in favor of homotransplantation and none in support of heterotransplantation.

Internal Secretion.—From the time when Brown-Séquard published his studies upon the internal secretion of the testicles, it has been believed that the ovaries likewise elaborate a somewhat analogous product, which plays an important part in the female economy. Indeed, the early work of Knauer (1900), Mandl, and others indicated that the secretion is directly concerned in maintaining the integrity of the other generative organs; inasmuch as they have shown that atrophy of the uterus and vagina rapidly follows the removal of the ovaries, whereas this does not occur when they are removed from their normal position and transplanted to other portions of the body. They therefore concluded that in such cases the absence of atrophy must be attributed to the action of the internal secretion of the transplanted ovaries, since all nerve connections were severed at the time of operation.

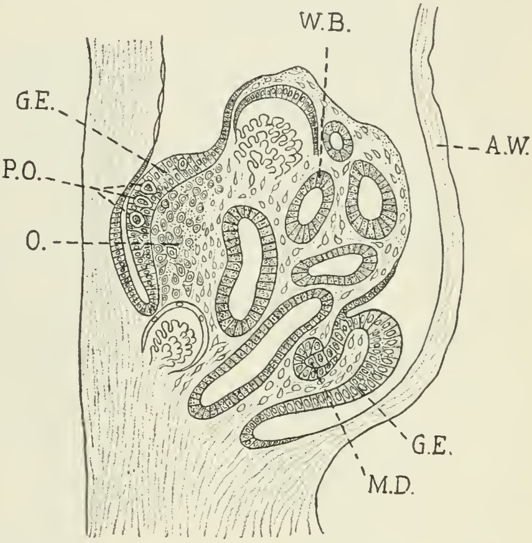

Fig. 67.—Section through Wolffian Body and Beginning Ovary and Müllerian Duct (Waldeyer). × 160.

A.W., abdominal wall; *G.E.*, germinal epithelium; *M.D.*, beginning müllerian duct; *O.*, beginning ovary; *P.O.*, primordial ova; *W.B.*, wolffian body.

Fränkel in 1903, and again in 1910, as the result of ingenious experiments and clinical work, stated that the internal secretion is elaborated in the corpus luteum. Notwithstanding considerable initial opposition, his views have obtained wide acceptance, and it is now generally believed that the structure has important secretory functions. Our ideas concerning the internal secretion of the ovary were still further clarified in 1923, when Allen and Doisy and their associates showed that the injection of the fluid contents of the graafian follicle into immature experimental animals at once brought on the œstrus cycle. This they attributed to the action of a hormone elaborated by the follicular epithelium, and which they designated as folliculin or œstrin. Their work obtained immediate acceptance, and later it was found that during pregnancy a similar hormone could be demonstrated in placental tissue, in the blood, and also in the urine. For details the reader is referred to the collective reviews of Allen and Doisy, of R. Meyer, and of Parkes (1929); while the monograph of Robert Frank gives an idea of the clinical utilization of such hormones. Philipp showed in our clinic in 1929 that this hormone passes into the fœtus during pregnancy, and is excreted through the fœtal urine for the first three or four days after delivery, after which it disappears.

Reference has already been made to the so-called "interstitial gland," and if one so designates the proliferation of theca cells, which occurs during pregnancy, it is probable that it also elaborates an internal secretion. This question will be still further studied after the structure of the corpus luteum has been considered.

Development of the Ovary.—An accurate idea of the structure of the ovary can be gained only through the study of its development. To Waldeyer we are indebted for much of our knowledge concerning the subject, though important preliminary work had been done by Valentin and Pflüger.

In 1870, Waldeyer published his monograph upon the Ovary and Ovum (*Eierstock und Ei*) and, although subsequent investigation has invalidated many of his conclusions, it must be regarded as the foundation of our knowledge of the subject. His work, which was based in great part upon the embryology of the chicken, showed that by the fourth day of development the cœlomic epithelium covering the inner surface of the wolffian body becomes differentiated from the surrounding tissue, its cells becoming larger and more cuboidal in shape, and some of them assuming a considerable size. Within a short time the epithelium proliferates to such an extent as to form a distinct elevation, which indicates the situation of the future ovary (Fig. 67). This epithelium Waldeyer designated as *germinal epithelium* and the large, clear cells found within it as *primordial ova*. As proliferation continues, a mass of cells is formed consisting of large primordial ova and smaller epithelial cells. By the upward growth of the connective tissue and blood vessels from the wolffian body, the epithelial masses become divided into smaller portions, the so-called egg-nests or Pflüger's tubes, which in turn become broken up into smaller and

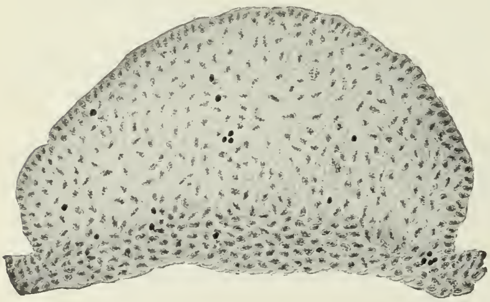

Fig. 68.—Sex Gland of Pig Embryo, 1.2 cm. long (Skrobansky).

smaller masses, until eventually isolated primordial ova are found, which are surrounded by a single layer of more or less flattened epithelium. These represent the primordial follicles.

Thirty-one years later, however, Waldeyer stated that the process was not so simple, and the work of Nagel, Winiwarter, Skrobansky, McIlroy, Felix, and Wilson clearly shows that in the higher animals, at least, the process of development is quite different. In either sex, the first trace of the sexual glands is found in a thickening of the epithelium on the inner surface of the wolffian body. These primitive sex cells rapidly proliferate and give rise to a distinct elevation, made up of closely packed undifferentiated epithelial cells, which are covered by a single layer of cuboidal cells arranged perpendicularly to the surface of the mass. The latter correspond to the future ovarian epithelium but take no part in the formation of ova and follicles (Fig. 68).

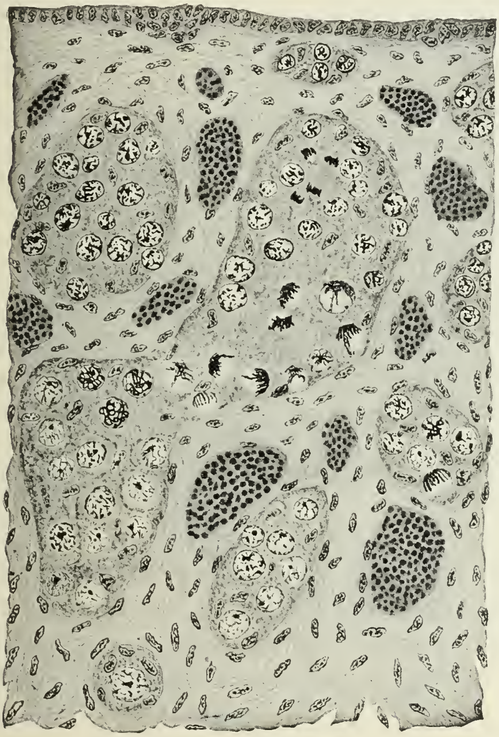

FIG. 69.—OVARIAN CORTEX OF PIG EMBRYO, SHOWING GERMINAL EPITHELIUM, PFLÜGER'S TUBES WITH OÖCYTES IN VARIOUS STAGES OF DEVELOPMENT (Skrobansky).

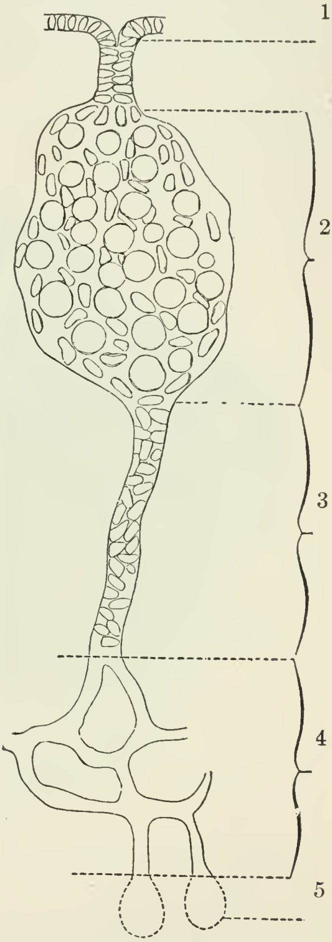

FIG. 70.—DIAGRAM SHOWING FORMATION OF OVARY (Winiwarter).

1, germinal epithelium; 2, germ tube; 3, medullary cord; 4, rete ovarii; 5, epoöphoron.

The cells of the primitive sex gland proliferate rapidly and invade the underlying stroma of the wolffian body, so that a cortical and medullary portion can be distinguished at an early period. The epithelial cells soon become broken up into irregular masses by the upgrowth of connective tissue and have little or no connection with the surface epithelium. The most deeply lying cells do not become differentiated, but extend downward as solid cords—the medullary cords. These terminate in a series of epithelial tubes—the so-called *rete ovarii,* which in turn communicate with the wolffian body tubules. In the female this is a transient condition, which disappears early in fœtal life, but in the male it is permanent and affords a ready explanation for the utilization of the wolffian ducts as the efferent channels of the testicles (Fig. 70). The more superficial cells become arranged in irregularly shaped masses, continue to proliferate, and soon show signs of differentiation. Many become large cells with prominent clear nuclei, whose chromatin takes on a different arrangement, while others retain their original appearance. The former are the oögonia, from which the ova are to be developed, while the latter give rise to the follicular epithelium.

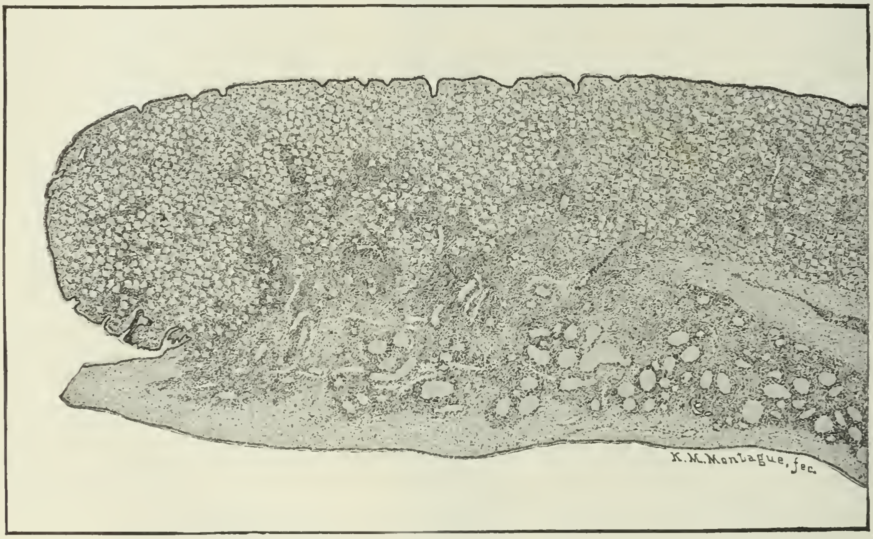

Fig. 71.—Ovary of New-born Girl. × 22.

After a certain period the oögonia cease proliferating, when the resulting cells become larger, and their chromatin undergoes a series of complicated changes, which eventually lead to the formation of the reticulated nucleus of the primordial ovum or oöcyte of the first order (Fig. 69). By the continued growth of connective tissue the masses of oöcytes and undifferentiated epithelial cells become still further broken up, so that eventually each oöcyte is surrounded by a single layer of flattened cells, thus giving rise to a primordial follicle.

That there is no essential difference between the differentiated and undifferentiated cells is shown by the fact that the cells of the medullary cord, which are of the latter variety, may develop into typical oöcytes; these, however, do not give rise to primordial follicles, but degenerate in situ. It would thus appear that the primordial ova or oöcytes do not develop from the surface epithelium, but rather from the undifferentiated cells of the primitive sexual glands.

This process has been observed by all recent investigators in rabbits, pigs, and human beings. In the latter the formation of oöcytes ceases before birth, but in some of the lower animals, especially in the bat, the process may continue throughout life.

At birth the greater part of the ovary consists of the cortex, which is made up of closely packed primordial follicles, which are separated from one another by very thin bands of connective tissue, although occasionally small groups of follicles may be in direct contact (Figs. 71 and 72). At this period the surface of the ovary is covered by a single layer of cuboidal epithelium which shows no signs of proliferation.

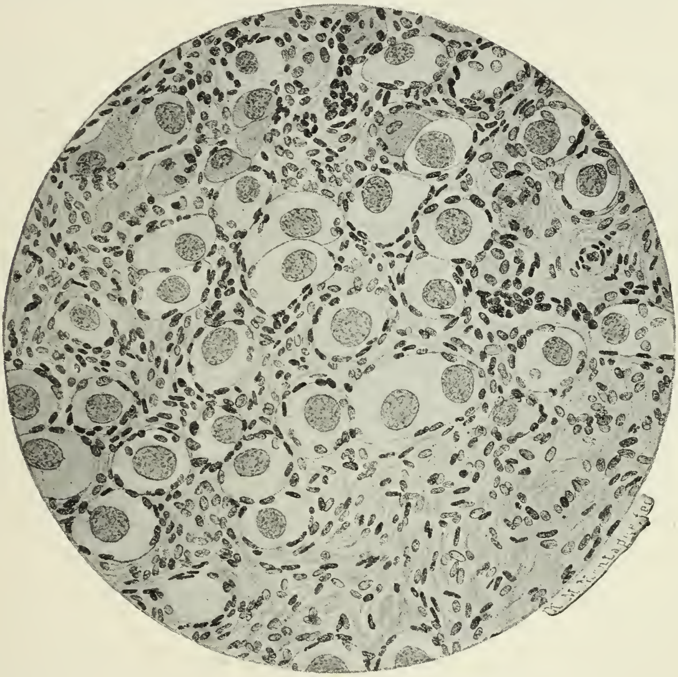

FIG. 72.—CORTEX OF HUMAN OVARY AT BIRTH SHOWING PRIMORDIAL FOLLICLES. × 300.

All authorities agree that the primordial ova are derived from the primary sex cells, but there is still considerable discussion as to the origin of the latter. Certain authorities hold with Boveri that they represent a specialized type of cell, which is a direct descendent from one of the early blastomeres of the segmenting ovum. Later these cells find their way to the vicinity of the developing ovary—the so-called "Keimbahn." Most investigators, however, believe that the primary sex cells develop in situ.

On the other hand, the discussion concerning the origin of the epithelium surrounding the primordial ova may be regarded as settled in favor of the original view of Waldeyer that the *follicular epithelium* is derived from the cells of the germinal or sexual epithelium, which have not been converted into oöcytes. Kölliker believed that it originated from the epithelium of the wolffian bodies, and that the medullary cords in the adult ovary represented portions which had not been utilized in this way, but his views are no longer accepted.

In rare instances the surface epithelium of the ovary may be ciliated, and now and again, as has been pointed out by von Velits and myself, the follicular epithelium may likewise be found to possess cilia. These observations, in spite of their rarity, speak strongly against the connective-tissue origin of the follicular cells.

Microscopic Structure of Ovary.—From the first stages of its development until after the menopause the ovary is undergoing constant change. According to Waldeyer, each ovary at birth contains at least 100,000 oöcytes, the majority of which disappear before the age of puberty; so that at that time only 30,000 to 40,000 remain, and these disappear during the following thirty years. That this is a moderate estimate is shown by the fact that Häggström was able to count 400,000 follicles in the ovaries of a twenty-two-year-old woman. As only one ovum is ordinarily cast off each month, it is apparent that a few hundred ova would suffice for the purposes of reproduction. The mode by which the others disappear will be considered when we take up the study of the corpus luteum and follicular atresia.

Before considering the structure of the mature follicle, it may be well to mention certain historical points in connection with it. The graafian follicle was first described in 1672 by de Graaf, a physician of Delft, who not only observed the vesicles in women but demonstrated the presence of ova in the tubes of rabbits. The human ovum was first recognized by von Baer, in 1827, its nucleus or germinal vesicle by Purkinje in 1830, and its nucleolus or germinal spot a few years later by Wagner.

In 1891, Boveri pointed out that the nomenclature usually employed in connection with the specific cells of the ovary was faulty. He contended that the terms ovum and egg are synonymous, and should therefore be restricted to cells which are ready for fertilization. As this is the case only after the completion of maturation and the casting off of the polar bodies, he suggested that other terms be employed prior to that period. Accordingly, he designated the cells during the stage of division as oögonia, from then until maturation begins as oöcytes of the first order, after the formation of the first polar body as oöcytes of the second order, and as ova only after the formation of the second polar body.

In the young child the greater portion of the ovary is composed of the cortex, which is filled with large numbers of closely packed primordial follicles, those nearest the central portion of the ovary showing the most advanced stages of development. In young women the cortex is relatively thinner, but still contains large numbers of primordial follicles separated by bands of connective tissue, cells with spindle-shaped or oval nuclei. Each primordial follicle consists of an oöcyte and its surrounding single layer of epithelium. The cells composing the latter are small and flattened, spindle-shaped, and are somewhat sharply differentiated from the still smaller spindle-shaped cells of the surrounding stroma (Fig. 73).

The oöcyte is a single large cell, more or less round in shape, with a clear protoplasm and a tolerably large nucleus occupying its central portion. The nucleus presents a marked reticulated network and at one point a well-defined nucleolus, as well as numerous accessory nucleoli, which are formed at the intersections of the nuclear threadwork. According to Nagel, the oöcyte remains constant in size from birth until the beginning of the transformation of the primordial into the typical graafian follicle, no matter at what period of life this change may occur. These primordial ova, or oöcytes of the first order, measure from 48 to 69 microns, and their nuclei from 29 to 32 microns in diameter.

Occasionally a primordial ovum may contain two nuclei or germinal vesicles, as has been shown by Nagel, Klein, von Franqué, and others. Again, occasionally two and sometimes three distinct ova may be found in a single primordial follicle, and it is from such structures that multiple pregnancies were formerly supposed to develop.

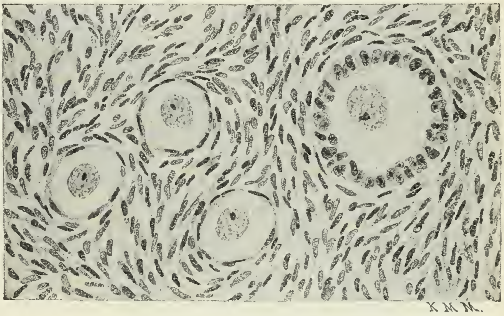

Fig. 73.—Ovary of Young Woman, Showing Primordial Follicles on Left Side and Follicle Just Beginning to Develop on Right. × 210.

When, under the influences of factors with which we are as yet unacquainted, the primordial follicle begins to mature, we notice in the first place that its epithelium becomes converted into a single layer of cuboidal cells (Fig. 73). Nuclear figures soon made their appearance, and the cells begin to proliferate rapidly, so that in a very short time the ovum becomes surrounded by a number of layers of epithelial cells. Certain of these undergo degeneration, and vacuolated areas are not infrequently observed between them. This process continues until a considerable portion of the follicle is filled with fluid, which is formed partly by the degeneration of the follicular cells and partly by transudation from surrounding vessels.

Coincident with the development of the fluid, the so-called *liquor folliculi,* the ovum becomes pushed to one side of the follicle, where it is surrounded by a mass of cells—the *discus proligerus* or *cumulus oöphorus*—while the rest of the epithelium is arranged in a number of layers around the interior of the follicle, and is known as the *membrana granulosa* (Fig. 76).

While these changes are taking place, the ovum itself becomes larger, important changes take place in its nucleus preparatory to the formation of the first polar body, yolk granules, or deutoplasm, are deposited in its protoplasm, and a thin, transparent structure—the zona pellucida—appears about its periphery. At the same time, the stroma immediately surrounding the growing follicle becomes vascular, and its cells show marked evidences of proliferation. The membrana granulosa is separated from the stroma by a thin basement membrane consisting of a single layer of flattened, spindle-shaped connective-tissue cells. Just between the basement membrane and the outermost layer of the membrana granulosa there not infrequently appears a thin, transparent layer, which was first described by Grohe and Slavjansky. This, no less than the zona pellucida, is a species of exudate from the granulosa cells.

Mature Graafian Follicle.—From birth until the cessation of sexual life, graafian follicles are constantly being developed. Before the age of puberty they are found only in the deeper portions of the cortex, and do not reach the surface of the ovary; later, however, they develop in the superficial portions of the cortex and make their way to the surface, where they appear as transparent vesicles, varying from a few to 10 or 12 millimeters in diameter. As the follicle approaches the surface of the ovary its walls become thinner and more abundantly supplied with vessels, except in its most prominent projecting portion, which appears almost bloodless and is designated as the *stigma,* the spot where rupture is to occur.

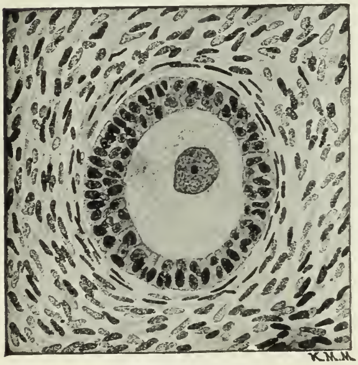

Fig. 74.—Developing Follicle. × 210.

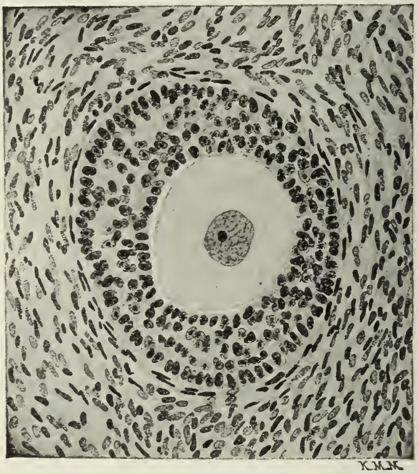

Fig. 75.—Developing Follicle. × 210.

From without inward, the mature graafian follicle consists of a connective-tissue covering—the theca folliculi; an epithelial lining—the membrana granulosa; the ovum, and the liquor folliculi. The *theca folliculi* is readily divided into two layers: an outer, the tunica externa, and an inner, the tunica interna. The tunica externa consists of the ordinary ovarian stroma, which is arranged concentrically about the follicle, while the connective-tissue cells of the tunica interna have undergone marked change.

Almost as soon as the primordial follicle shows signs of development, nuclear figures appear in the stroma immediately surrounding it, and a considerable multiplication of cells occurs. These become considerably larger than the surrounding connective-tissue cells, and as the follicle increases in size assume a granular appearance, which is due to the presence of fat and of a yellowish pigment. These cells are designated at *theca lutein cells* and, as will be seen later, play an important part in the formation of the corpus luteum, as well as in the process of follicular atresia. In most hardened specimens the fatty matter has been dissolved out, and the cells appear not unlike those of the suprarenal capsules (see *T.I.*, Fig. 77). At the same time there is a marked increase in the vascularity of the theca, and numerous lymphatic spaces make their appearance.

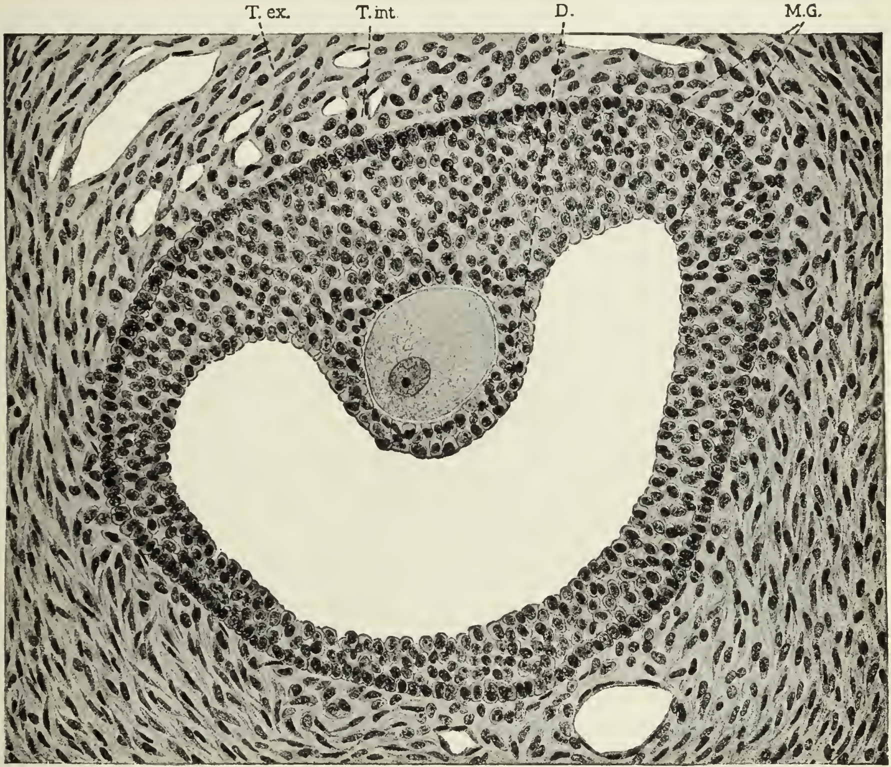

FIG. 76.—FOLLICLE APPROACHING MATURITY. × 210.
D., discus proligerus; *M.G.*, membrana granulosa; *T.ex.*, tunica externa; *T.int.*, tunica interna.

The epithelial lining of the follicle, or *membrana granulosa,* consists of a number of layers of small polygonal or cuboidal cells, with round, darkly staining nuclei, which are arranged in fewer layers the larger the follicle. At one point the membrana granulosa is much thicker than elsewhere, and forms a more or less pyramidal mound in which the ovum is included. This is the *discus proligerus* or *oöphorus,* and while the follicle is developing it is situated at the portion farthest removed from the surface of the ovary, but, according to Strassmann, as the follicle approaches maturity it tends to move toward the surface, eventually assuming a position corresponding to X or II on the face of a clock. The follicle is filled with a clear, albuminous fluid, the *liquor folliculi,* which is partly the product of the degenerated follicular epithelium and partly a transudate from surrounding vessels. According to Allen and Doisy, and all subsequent investigators, the liquor contains the specific internal secretion of the ovary—folliculin or œstrin. As the follicle approaches its highest development, its epithelium undergoes fatty degeneration, as can be demonstrated by appropriate technic.

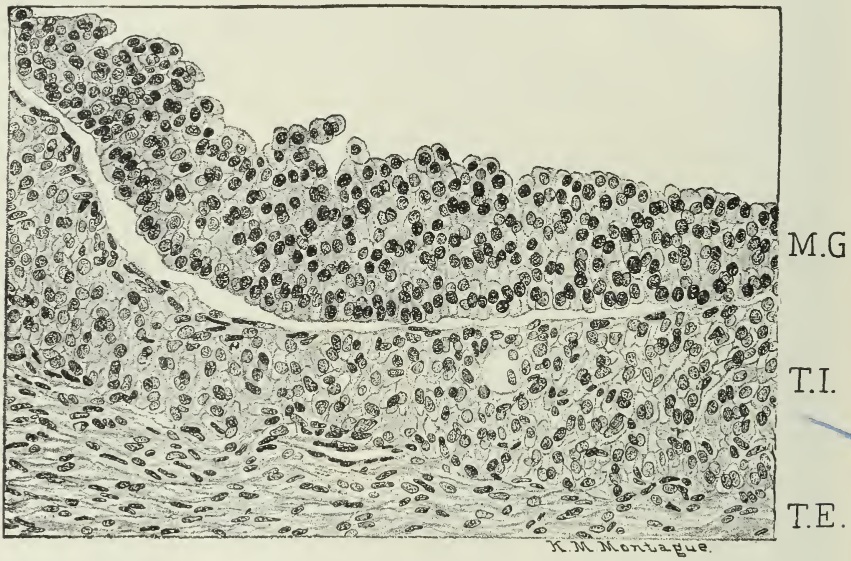

Fig. 77.—Section through Wall of Mature Follicle (Highly magnified). *M.G.,* membrana granulosa; *T.I.,* tunica interna; *T.E.,* tunica externa.

As the ovum approaches maturity, it becomes the largest cell in the body, and, according to Nagel, measures from 150 to 250 microns (1/5 millimeter) in diameter, as compared with 48 to 69 microns in its primordial condition; while Jackson estimates that it weighs 0.000004 gram. In 1928, Allen and his associates succeeded in isolating 7 human ova during their transit through the fallopian tube. They differed considerably in size, varying from 0.084 to 0.184 micron in diameter.

If the nearly *mature ovum* be examined in the liquor folliculi or in normal salt solution, the following structures may be distinguished in and about it: (*a*) a corona radiata; (*b*) a zona pellucida; (*c*) a perivitelline space; (*d*) a small clear zone of protoplasm; (*e*) a broad, finely granulated zone of protoplasm; (*f*) a central, deutoplasmic zone; (*g*) the germinal vesicle with its germinal spot; and, if appropriately stained (*h*) a centriole, and (i) many mitochondria.

The *corona radiata* consists of a number of layers of follicular epithelium which adhere to the ovum, and was so designated by Bischoff, by whom it was first described in the rabbit. Inside of the corona radiata comes a narrow, transparent zone—the *zona pellucida*—which is a product of the granulosa cells, and does not belong to the ovum itself. Separating the ovum from the zona pellucida is a clear, narrow space, the *perivitelline space,* within which the ovum is freely movable, so that no matter what position it may assume its germinal vesicle will always point upward. Inside of the perivitelline space is the ovum proper, which differs from the primordial oöcyte, not only by its increased size, but more especially by the presence of a yolk or deutoplasm, which fills the greater part of its interior.

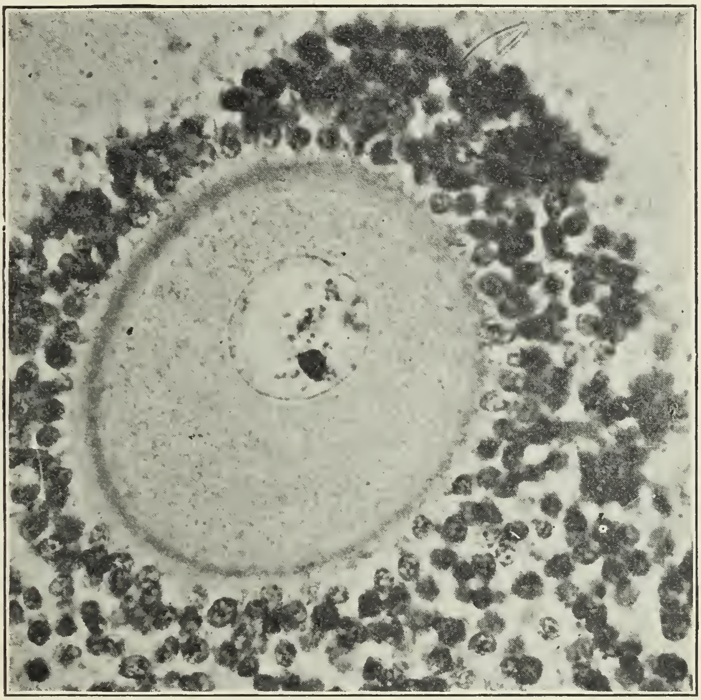

Fig. 78.—Mature Human Ovum. × 480. (Carnegie Laboratory.)

The *deutoplasm* occupies the central portion of the ovum, and is made up of large numbers of irregularly shaped, highly refractive granules. As it develops it pushes the germinal vesicle to one side, so that the latter always assumes an eccentric position in the ovum. Outside of the deutoplasm comes a narrow zone of finely granular protoplasm, which owes its peculiar appearance to the presence of very small yolk granules; external to this, again, is a still narrower zone of clear protoplasm. Corner, however, believes that this statement is incorrect, and that the human ovum is almost devoid of yolk granules.

The *nucleus* or *germinal vesicle* presents a distinct reticular, nuclear network, the intersections of which appear as very darkly staining points. The nucleolus or *germinal spot* is much larger than in the primordial ovum, and according to Auerbach presents ameboid movements.

Mitochondria, according to Van der Stricht, are present in large numbers in the ova, and after fertilization pass into the blastomeres and thus to all cells of the embryo.

An ovum presenting the above characteristics is generally described as mature, but is not capable of fertilization and further development until it has undergone certain changes, which are designated as maturation, and manifested by the formation and casting off of the polar bodies.

Graafian follicles, as we have already pointed out, develop throughout childhood, and occasionally attain a considerable size; but they rarely rupture at this time on account of their position in the depths of the ovary and undergo atresia in situ. In adults, on the other hand, the developing follicle usually makes its way to the surface, and when it has attained its highest development ruptures and extrudes its ovum into the peritoneal cavity or the tube, where it may be fertilized.

Formerly it was believed that *rupture of the follicle* was brought about by the increased tension resulting from the rapid formation of the liquor folliculi. It is now believed to be a more complex process, and to be due primarily to circulatory changes. As the period of ovulation approaches, the ovary becomes engorged with blood and, the intra-ovarian tension being markedly increased, the growing ovum is forced to the surface; at the same time the circulation in the most distended portion of the wall of the follicle is interfered with, whence results necrosis at the point designated as the stigma, which eventually gives way.

Corpus Luteum.—The corpus luteum, or the granulosa gland as it is called by Aschoff, is a structure which is formed at the site of a ruptured follicle. When the mature follicle ruptures, the ovum, liquor folliculi, and a considerable portion of the degenerated membrana granulosa make their escape, and the walls of the empty follicle collapse. In a short time, however, its cavity becomes filled with blood, which is derived partly from the vessels at the point of rupture, but principally from those of the tunica interna of the theca.

The corpus luteum, therefore, in its earliest stages is simply a ruptured follicle filled with blood, outside of which is a narrow yellow ring formed by the theca lutein cells. It is now generally believed that the granulosa cells, which are not cast off at the time of rupture, proliferate rapidly and invade the blood-filled follicle, forming a festooned layer about its central blood clot (Fig. 79). This layer is yellowish in color, whence the term "corpus luteum." As the structure becomes older, the yellow ring becomes thicker and thicker, until at last it almost entirely fills the interior of the follicle, the central blood clot remaining being now quite small.

At its period of greatest development, namely, about fourteen days after rupture, the corpus luteum is always larger than the original follicle, and may sometimes occupy as much as one-third of the entire ovary.

Microscopic sections through a well-developed example show that its center is occupied by a compressed blood clot, immediately outside of which is a thin layer of newly formed connective tissue. The greater part of the structure, however, is occupied by the festooned yellow ring, which is made up of large, polygonal, epithelioid cells, with small, round, somewhat faintly staining nuclei. These are the *lutein cells,* whose protoplasm presents a granular or vacuolated appearance, resulting from the disappearance of neutral fat and various lipoids which have been dissolved out by the various substances used in the fixation of the tissue or in the preparation of the microscopic slides. The color, characteristic of the fresh state, is due to a pigment which is soluble in alcohol, chloroform or ether, and which, according to Escher, is chemically identical with carotin—the coloring matter found in carrots. The layer of lutein cells is traversed by numerous radiate, tolerably thick, connective-tissue partitions, growing up from the theca, to which it owes its festooned appearance. They are richly supplied with blood vessels and lymphatics (Fig. 80). Corner, who has carefully studied the cytology of the lutein cells, reports that it is unusually

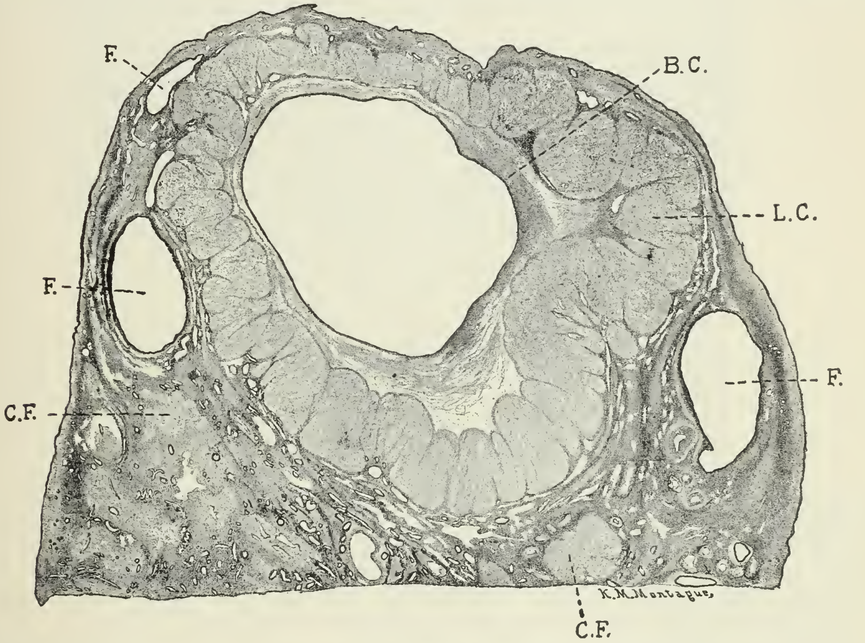

FIG. 79.—PORTION OF OVARY, SHOWING A CORPUS LUTEUM OF PREGNANCY, WITH CYSTIC CENTER. × 4.
B.C., blood clot; *C.F.,* corpus fibrosum; *F.,* graafian follicles; *L.C.,* lutein cells.

complicated. Varying statements are made concerning their fatty contents, and the work of Kaufman and Raeth indicates that the histochemical reactions by no means correspond with the results of accurate chemical analysis, so that many statements contained in the literature must be taken with reserve.

As the cavity of the follicle is encroached upon by the growing lutein cells, the blood clot becomes more and more compressed, and vascular loops extend into it and soon cause its organization. At the same time, the blood pigment is removed by leukocytes, which can be found in the surrounding tissue with their bodies filled with particles of it. Occasionally, hemorrhage does not take place into the ruptured follicle, and a corpus luteum is formed without a central blood clot. This is the exception in human beings, but the rule in many of the lower animals.

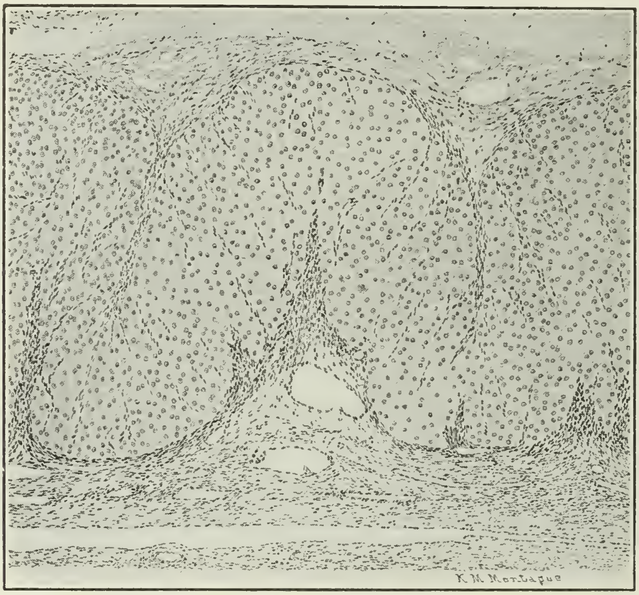

Fig. 80.—Section through Yellow Layer of Corpus Luteum, Showing Lutein Cells.

After the cavity of the follicle has become obliterated by the ingrowth of the lutein cells and connective tissue, degenerative changes soon make their appearance in the former, some of which undergo hyaline, and others fatty, degeneration. In young women, in whom the circulation is active, the degenerated lutein cells are rapidly absorbed, so that in a short time the corpus luteum becomes replaced by newly formed connective tissue which corresponds closely in appearance to the surrounding ovarian stroma. But in more advanced life, when the ovarian circulation has become impaired, absorption goes on less rapidly; and not infrequently the degeneration extends to the intervening connective tissue and blood vessels until the entire structure is converted into an almost homogeneous mass of hyalin in which only a few connective-tissue cells and degenerated blood vessels can be seen (Fig. 81). These structures—the so-called *corpora fibrosa* or *albicantia*—present on fresh section a dull white appearance, somewhat suggestive of old scar tissue. They are, however, gradually invaded by the surrounding stroma, and become broken up into smaller and smaller hyaline masses, which are eventually absorbed, the site of the original follicle being indicated only by an area of slightly thickened connective tissue. When the circulation is very defective, absorption takes place much more slowly, so that it is not uncommon to find the ovaries of women near the menopause almost filled by corpora fibrosa of varying size. Frequently the small hyaline bodies resulting from the breaking up of these structures assume peculiar and bizarre forms, and very often present a curved and twisted appearance suggestive of a degenerated artery (Fig. 82). Similar structures are sometimes left after the obliteration of nonruptured follicles.

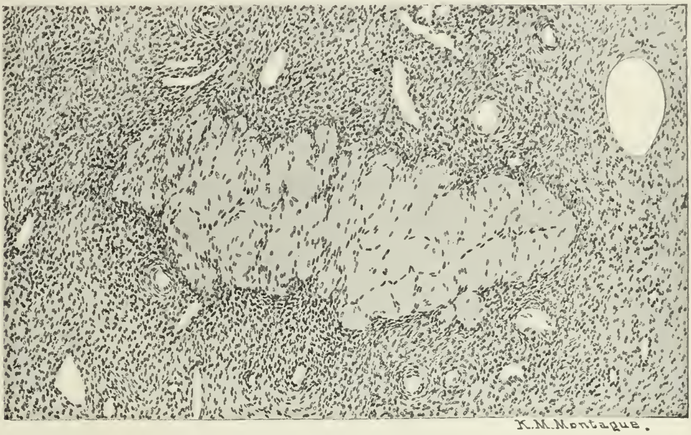

Fig. 81.—Corpus Fibrosum. × 75.

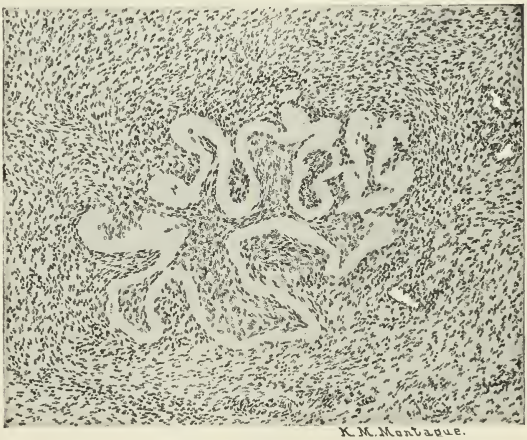

Fig. 82.—Later Stage of Corpus Fibrosum. × 75.

Practically all authorities are agreed as to the life history of the corpus luteum, and the only point which still remains unsettled deals with the *origin of the lutein cells.* As indicated in the collective review of Asdell (1928), three main views have been advanced—(*a*) that the lutein cells are of connective-tissue origin and are derived from the cells of the theca interna; (*b*) that they are derived from the proliferation of the cells composing the membrana granulosa; and (*c*) that they are derived from both sources, when one has to deal with a mixture of connective tissue and of epithelial cells. The first view was advanced one hundred years ago by von Baer, and has found numerous supporters. For years I believed in it, and abandoned it only after I had become convinced that it was incorrect. The second view was first advanced by Bischoff, but found few advocates until after Sobotta had demonstrated its correctness in the rat. Since that time a constantly increasing number of investigators have shown that, following the rupture of the follicle, the cells of the membrana granulosa, instead of being exfoliated as was previously taught, rapidly proliferate, soon fill the cavity and become the true lutein cells. The third view was particularly advocated by Corner, Evans and others, but has found only limited acceptance.

I now believe in the granulosa origin of the characteristic cells of the human corpus luteum. Attention has already been directed to the changes which occur in the cells of the tunica interna of the theca during the growth of the follicle, and in every well-developed corpus luteum which I have studied, groups of such cells can be demonstrated about the periphery of the corpus luteum and often in the strands of connective tissue invading it, so that theca cells in many instances may become admixed with granulosa lutein cells. Generally speaking, however, the two types of cell are sharply differentiated; the granulosa lutein cells being larger, more vacuolated and provided with a smaller nucleus, while the theca lutein cells are somewhat smaller, stain more deeply and have a relatively larger nucleus.

On the other hand, the theca lutein cells play a prominent part in the life history of follicles which degenerate in situ without rupture. This process, which is designated as follicular atresia, has been studied by many observers, notably Slavjansky, Stevens, Seitz, and Wallart, and, as will be noted later, is particularly pronounced during pregnancy. In such circumstances, after the follicle has attained a certain size, the ovum undergoes cytolysis, the membrana granulosa degenerates, is cast off into the liquor folliculi, and eventually is absorbed. While these changes are in progress, the theca lutein cells proliferate and form a tunic many layers thick about the follicle, which frequently assumes a yellowish coloration. Eventually, as the liquor folliculi disappears, the walls of the follicle collapse and the theca cells composing it undergo fatty and hyaline change, so that finally an irregularly hyaline body results, which cannot be distinguished from a similar structure derived from a corpus luteum, or even from a degenerated vessel.

It should be remembered that atresia is the fate of the vast majority of follicles which develop beyond the primordial stage, and that the process begins during intra-uterine life and continues until after the menopause; while corpora lutea develop only from the comparatively small number of follicles which rupture after reaching maturity. The earlier observers considered that the changes in the corpus luteum were analogous to the organization of a blood clot, but at present such a view has only an historical interest. Possibly, the least important function of the corpus luteum is to bring about the obliteration of the spaces left by the ruptured follicles without the formation of cicatricial tissue; for if they healed by the latter process it is evident that in a very short time the entire ovary would be converted into a mass consisting of nothing but scar tissue, the very nature of which would effectually prevent further ovulation. It has been estimated by Clark that if each follicle healed in this manner, and if ovulation could continue under such conditions, a fibroma 3000 times as large as the original ovary would eventually be produced.

Following the appearance of Fränkel's articles in 1903 and 1910, it is generally believed that the chief function of the corpus luteum is the elaboration of an internal secretion which regulates the blood supply of the uterus, and thus controls the process of menstruation, as well as the changes which occur in the endometrium to fit it for the implantation and the nutrition of the ovum. The experimental work of Corner and Allen, in 1929, placed this view upon a firm foundation. They found if rabbits were castrated eighteen hours following coitus and killed five to six days later that the characteristic changes in the uterine mucosa did not occur and that dead ova would be found in the uterine cavity. On the other hand, if a specially prepared extract of corpus luteum were injected immediately following castration, and the injection repeated daily until the animal was killed, they found that the uterine mucosa underwent the usual changes and that living ova had become attached to it just as in normal pregnancy. In other words, they proved that an extract prepared from the corpus luteum of the sow had the same effect as the hormone derived from the living corpus luteum of the rabbit, and that one or the other is essential to the implantation of the ova.

Such statements, however, in no way militate against the acceptance of the current views concerning the significance of the folliculin which is elaborated in the growing follicles, and which appears to regulate the œstrus cycle. Indeed, the entire question of the internal secretion of the ovary is extremely complicated; as the researches of Smith and Engle, and of Zondek and Aschheim indicate that it is closely connected with the activity of the hypophysis, and as Evans and Simpson believe with the basophilic cells of that organ. These researches show that the implantation of small particles of the anterior lobe of the hypophysis into immature animals promptly results in the inauguration of the œstrus cycle; or, as Zondek and Aschheim express it, the hypophysis should be regarded as the motor of the sexual function, and acts upon the ovary, whose hormones in turn produce the characteristic changes in the uterus and vagina.

Following the pioneer work of Dalton in 1851, it is customary to distinguish between *true* and *false* corpora lutea—namely, those following impregnation and menstruation, respectively. This distinction is based upon their relative size, and not upon any inherent anatomical difference, as they both present the same histological structure, the larger size of the so-called true corpus luteum being simply due to the increased vascular supply incident to pregnancy. J. W.

Miller, in 1914, stated that the two varieties could easily be differentiated by microchemical methods. He held that neutral fat could not be demonstrated in the corpus luteum of pregnancy until after delivery, but that areas of colloid and of calcification soon appear; while in the corpus luteum of menstruation fat is readily demonstrable, but colloid and calcification are absent. I have no experience with these criteria, but the chemical analyses of Kaufman and Raeth, to which reference has already been made, would indicate that one should guard against drawing premature conclusions.

Not infrequently the corpus luteum of pregnancy contains in its center a small cyst filled with clear fluid, the walls of which are composed of connective tissue, outside of which are the typical lutein cells. Such cysts are due to the liquefaction of the central blood clot (see Fig. 79).

In rare instances, the corpus luteum, instead of disappearing in the manner just described, may be the starting point of cystic formations, to which attention was first directed by Rokitansky, and with which every gynecologist is now familiar.

The corpus luteum was first described by de Graaf as a conglomerate glandular body, and was considered by him and all earlier authorities as positive evidence of previous childbearing. Moreover, it was generally believed that the number of children which a woman had borne could be estimated by counting the number of corpora lutea in her ovaries. This view was held for many years, and was so firmly established, even at the end of the eighteenth century, that such eminent authorities as Abernethy, Sir Astley Cooper, and Denman had no hesitancy in testifying in a medicolegal case that a woman had been pregnant because a corpus luteum was found in one ovary. Even after the more frequent performance of autopsies, and the closer attention directed to the condition of the ovaries had led to the abandonment of this view, it was for a time believed that the presence of corpora lutea indicated that the individual had indulged in sexual relations, or had at least been under marked sexual excitement. Finally, as a result of the work of Bischoff, Raciborski, Négrier, and Pouchet (1840-1847), it was definitely established that a corpus luteum developed with each menstrual period in virginal as well as married women. For fuller information on this point the works of Montgomery and Dalton may be consulted.

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SECTION II

PHYSIOLOGY AND DEVELOPMENT OF THE OVUM

CHAPTER III

MENSTRUATION AND OVULATION—MIGRATION OF THE OVUM AND PLACE OF MEETING OF OVA AND SPERMATOZOA

Menstruation.—By menstruation we understand one of the manifestations of the cyclic process associated with ovulation, which is characterized by a discharge of blood from the genitalia, and which recurs at regular intervals, except during pregnancy and lactation, from the time of puberty until the menopause. Ordinarily it comes on every four weeks and lasts from three to five days, though there are marked individual variations as to its frequency and duration.

The age at which the menses are established varies in different countries, being earlier in warm and later in cold climates. In the temperate zone the first menstruation does not usually occur before the fourteenth or fifteenth year. Not a few instances of a much earlier appearance of the function, however, are to be found in the literature, and are usually associated with precocious sexual development. One of the most notable cases of this character is that of Anna Mummenthaler, who, according to Haller, menstruated regularly from her second year, and gave birth to a full-term child at the age of nine.

Frequently a bloody vaginal discharge is observed in new-born infants, which ceases after a few days, no further discharge occurring until puberty. To describe these as instances of precocious menstruation, however, would be incorrect; more particularly as Halban attributes the loss of blood, as well as the occurrence of milk in the breasts of infants, to the circulation of a hormone probably derived from the placenta.

In this country the menopause usually occurs about the forty-fifth year. In rare instances, however, the menstrual flow may cease as early as the twenty-eighth or thirtieth year, while occasionally it continues until well into the fifties, or even until a later period. Thus, Kennedy reported the case of a woman who gave birth to her twenty-second child when she was sixty-three years old, after which she still continued to menstruate. For various interesting historical and ethnological data concerning menstruation, the reader is referred to the monumental work of Ploss.

The menstrual flow is derived from the uterine mucosa, and consists of blood mixed with mucus, and cast-off fragments of endometrium, and in ordinary circumstances, does not coagulate. It contains fewer red cells and more lymphocytes than the circulating blood; and, according to Schickele, and Stickel and Zondek, the absence of coagulation is due to substances formed in the uterine tissues, as the fluid expressed from the uterus under high pressure inhibits coagulation when added to normal blood. Moreover, Bell has shown that the menstrual discharge is rich in calcium, while at the same time its amount in the circulating blood is diminished. It also contains some toxic substance, whose nature is as yet unknown. Attention was directed to this fact, in 1920, by Schick, who demonstrated that contact with a menstruating woman would cause flowers to wither promptly, whereas controls retained their freshness. In our pharmacological laboratory, Macht and Lubin demonstrated that the legume, lupinus albus, would sprout luxuriantly when placed in a vessel of water, but that the addition of a few drops of menstrual blood would result in a striking inhibition of growth. This they attributed to the action of a toxic substance, which they have designated as menotoxin.

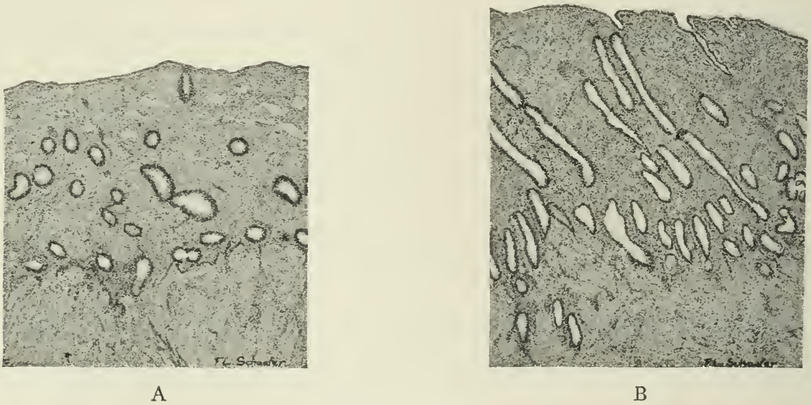
Hoppe-Seiler states that the quantity of blood lost at each menstrual period is greatly overestimated and rarely exceeds 37 cubic centimeters; while according to Labille the amount varies between 20 and 65 cubic centimeters. The former arrived at his conclusion by soaking in water all the napkins used by the woman during a single period, and determining the amount of hemoglobin in the solution, and the latter by determining the quantity of iron in the effused blood.

Anatomical Changes in Menstruation.—Until recently, the statements concerning the extent of the changes occurring in the endometrium during menstruation were very contradictory. Sir John Williams believed that the entire mucosa was cast off at each menstrual period, while Moericke and numerous other observers stated that there was little or no destruction of tissue. Between these extremes we find a number of authors stating that a greater or lesser portion undergoes disintegration. Generally speaking, the older authorities held that the entire mucosa, or at least a considerable part of it, was cast off.

In 1882, Moericke stated that menstruation was accompanied by little or no destruction of tissue, basing his statements upon the examination of 45 specimens of the menstruating endometrium which he obtained by curettage. His views were soon confirmed by other observers, notably by Gebhard and Findley.

These statements were made before the important contributions of Hitschmann and Adler, in 1908, had revolutionized our ideas concerning the structure of the endometrium. Prior to that time it was generally considered to be a thin membrane of relatively stable structure, and that the changes at the time of menstruation consisted in a certain amount of thickening and hyperemia, followed by the escape of blood into the uterine cavity, partly by diapedesis and partly by the rupture of distended capillaries.

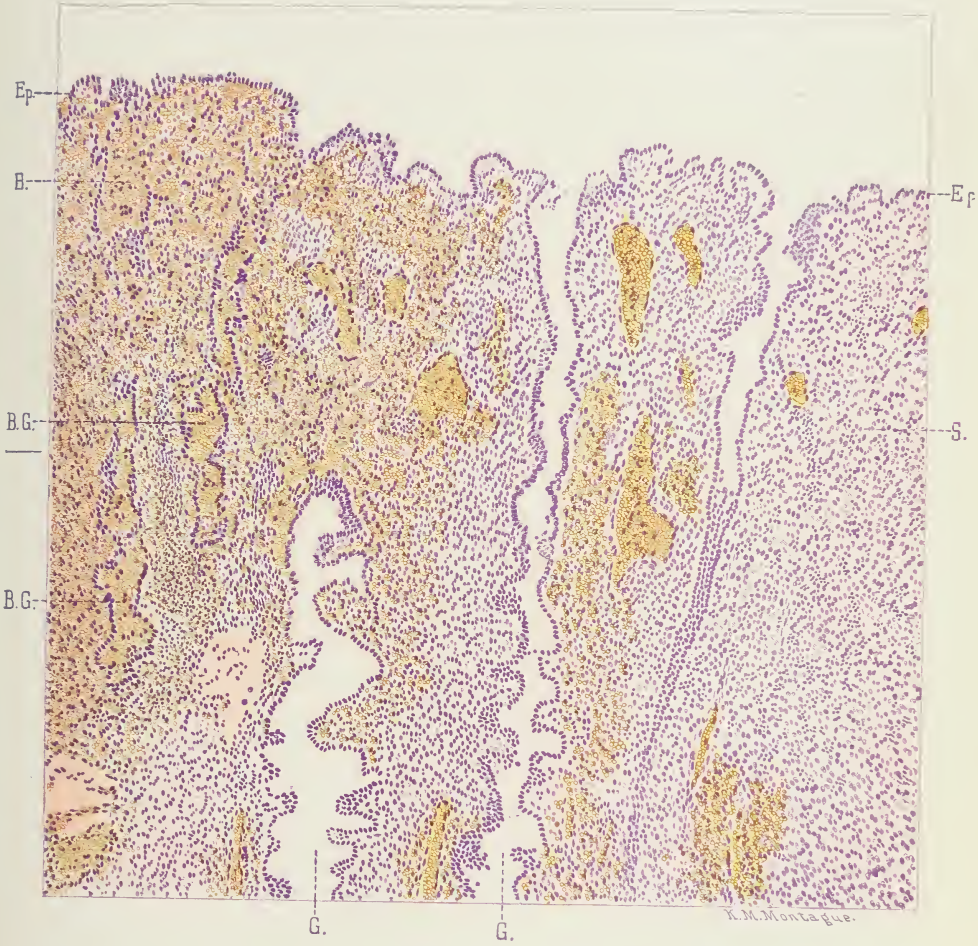
The investigations of Hitschmann and Adler, which have in great part been substantiated by all subsequent observers, and particularly by R. Schroeder (1928), show that the process is not so simple, but that the endometrium is undergoing constant change either in anticipation of or in recovery from the menstrual flow. This series of changes is designated as the menstrual cycle, and consists of four phases: menstruation, regeneration, interval, and premenstrual swelling. It is only in the last stages of the period of regeneration and the first part of the interval that the endometrium presents the histological structure which was formerly described as normal—namely, a thin mucous membrane with simple tubular glands. In the later part of the interval the endometrium begins to show distinct evidences of proliferation and soon passes into the state of premenstrual swelling, or the secretory phase. During this period, as the result of changes in both the stroma and glands, it becomes several times thicker than before, and presents the histological picture which was formerly considered characteristic of the so-called glandular endometritis. The stroma becomes loosened, and its cells lose their oval shape and become round or polygonal in outline, and approach the decidual cell in appearance. At the same time the glands undergo great hyperplasia, associated with an increase in the size of the lumina and the development of projections from their walls, thereby assuming a twisted or corkscrewlike appearance. The individual epithelial cells become somewhat larger and develop a marked secretory activity, so that upon appropriate staining the lumina are found to be filled by secreted material, which was absent in the earlier phases of the cycle. There is also a marked increase in vascularity, and distended capillaries and many leukocytes appear in the superficial layers. After this phase has existed for a number of days, blood escapes from the superficial layers and makes its way into the uterine cavity, whence it escapes as the menstrual flow. Following the discharge of blood, the endometrium becomes much thinner and regenerative processes commence, even before the flow has ceased (Figs. 83 to 85).



A B

Fig. 83.—Normal Endometrium.
Interval or resting stage. *A,* glands cut transversely; *B,* glands cut obliquely. × 30.

PLATE III.


Ep.
B.
B.G.
B.G.
Ep.
S.
G.
G.
K.M.Montague.

SECTION THROUGH ENDOMETRIUM ON THIRD DAY OF MENSTRUATION.
× 52.

B., blood; *B.G.*, gland filled with blood; *Ep.*, surface epithelium; *G.*, hypertrophied glands; *S.*, stroma.

Schroeder, Novak and TeLinde, and most modern observers believe that menstruation is always associated with considerable destruction of tissue, so that in most instances only the deepest layer of the mucosa, which is in contact with the muscularis, is retained. In my experience, however, such is not always the case, and Plate III, which represents the endometrium from a uterus removed on the third day of menstruation, shows distinctly that but little destruction of tissue has occurred. Figures 86 and 87 give an idea of the extent of the changes noted in two of my specimens from the first and third days of the period, respectively.

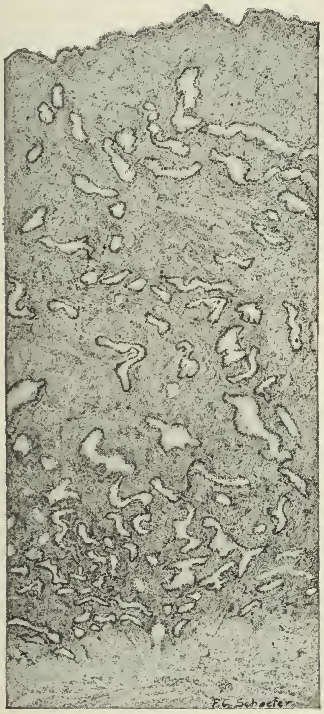


Fig. 84.—Normal Endometrium.
Early Premenstrual Period. × 30.

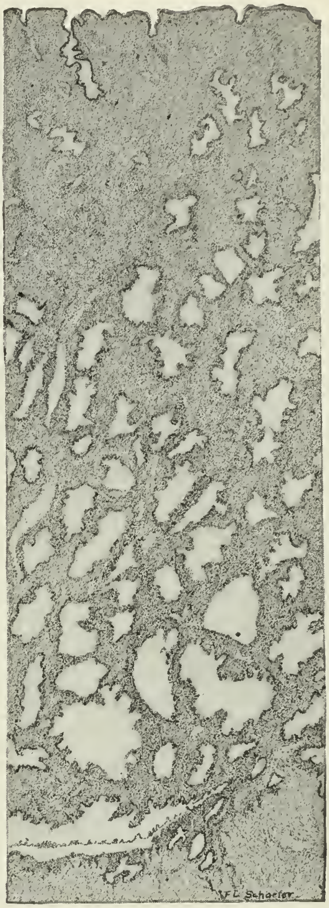


Fig. 85.—Normal Endometrium.
Advanced Premenstrual Period. × 30.

It accordingly appears that in the period of premenstrual swelling the endometrium becomes transformed into a thick membrane, which is almost indistinguishable from the decidua vera as seen in very early pregnancy (Fig. 86). Indeed, the likeness is so striking that not a few investigators employ the same terms in describing it, and distinguish a superficial compact and a deeper spongy layer; or, as Schroeder prefers to call them, a fuctionalis and a basalis. He holds that practically all of the former is cast off, while the new mucosa is regenerated from the latter. Consequently, it appears that the purpose of the premenstrual swelling is to prepare a suitable nidus for the reception and implantation of the fertilized ovum, and that menstruation sets in in case pregnancy fails to occur. For this reason, Evans and others suggest that it would be more appropriate to designate this part of the cycle as pregravid rather than premenstrual. Evidence in favor of such a view is afforded by the observation of Aschheim and most subsequent investigators that large quantities of glycogen appear during the premenstrual period and practically disappear after the flow, indicating that it was stored to aid in the nutrition of the ovum, and disappears if implantation fails to occur.

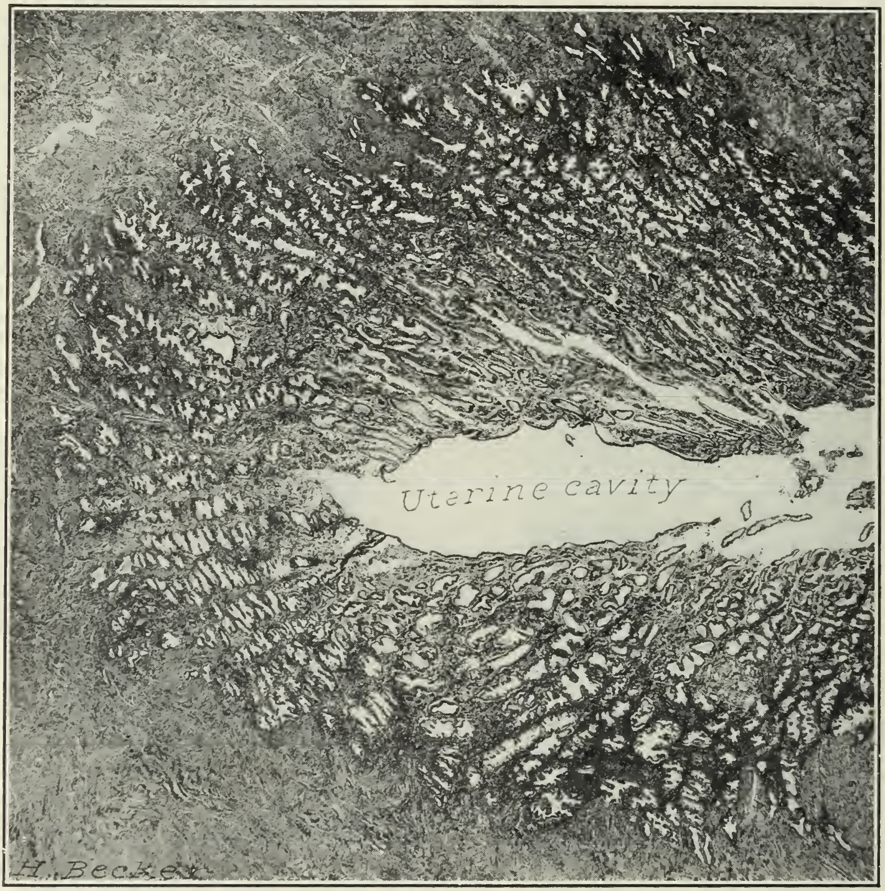


Fig. 86.—Early Menstruation.

Section through uterine cavity first day of menstruation, showing great hypertrophy of mucosa and relatively slight destruction of tissue. × 13. (Compare with Figure 144, showing early decidua vera.)

As will be indicated below, menstruation is now regarded as the last stage in a cycle resulting from the maturation of an ovum in case fertilization and pregnancy do not occur; and many writers associate it with degenerative changes occurring in the corpus luteum. Such a conception, however, has carried us only a short step farther, and at present we possess no explanation for the periodicity of ovulation.

In connection with the mechanism concerned in the production of the menstrual bleeding the researches of Schickele and of Frankl and Aschner are of interest. The former has shown that a substance can be expressed from the uterine tissue which possesses the property of lowering the blood pressure and of dilating capillaries; while the latter investigators have demonstrated the development of a tryptic ferment during the premenstrual phase.

Relation between Menstruation and Ovulation.—By ovulation we understand the rupture of a mature graafian follicle and the extrusion of the ovum. The relation between menstruation and ovulation has given rise to a great deal of controversy, and it is only within recent years that our ideas concerning it have approached clarification.

In every animal which has been intensively studied, it has been shown that a cycle of changes is regularly occurring in both the ovaries and uterus, which correlates the structure of the uterine mucosa to the various phases of ovarian activity, so that the animal goes into œstrus or "heat" whenever the mature follicle is ready to rupture, with the result that the fertilized ovum descends into a uterus fully prepared for its reception, and offering the most favorable conditions for its implantation. Such researches have been greatly facilitated by the discovery by Pananicolaou and Stockard that the examination of smears prepared from the vaginal secretion permits the recognition of the several phases of the œstrus cycle, which can be confirmed on killing the animal.

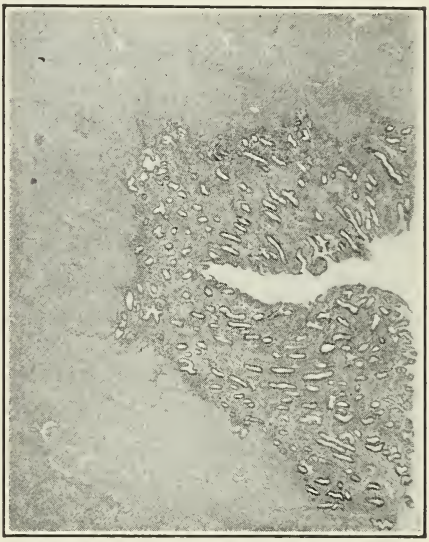


Fig. 87.—Late Menstruation.
Section through endometrium on the third day of menstruation showing extent of destruction of tissue and disappearance of convoluted glands. × 13.

Investigations along these lines have been made in the dog by Marshall and Halnan, in Dasyurus by Hill and O'Donoghue, in the opposum by Hartman, in the sow by Corner, in the guinea-pig by Stockard and Pananicolaou, in the rat by Long and Evans, in the mouse by many observers, and in the monkey by Corner, and by Hartman. All of them agree concerning the existence of a definite œstrus cycle in which the ovarian, uterine and vaginal changes are wonderfully correlated, and all attribute the cycle to the action of a hormone derived from the egg or its appendages, including the corpus luteum. Furthermore, the necessity for the circulation of some hormonic substance is further accentuated by the occurrence of hypertrophic changes in the mammary glands of many animals, independently of the existence of pregnancy, and especially by changes in the structure of the brood pouch in marsupials.

As œstrus in animals occurs at the time of ovulation, it is evident that it is not comparable with menstruation in women, and accordingly it must correspond to the early days of the period of premenstrual or pregravid swelling in women.

The fact that young girls cannot usually conceive until after the appearances of the menses, as well as the extreme rarity of impregnation after their cessation, rendered it natural for the earlier observers to suppose that conception could not occur without menstruation, and that the menstrual flow represented the female semen. This view, however, was soon abandoned, and the discharge came to be regarded as a process of purification.

It was not until the doctrine of periodical ovulation had been established by the work of Gendrin, Negrier, Bischoff, Pouchet, and others that definite ideas could be formulated concerning the relation between ovulation and menstruation. From then on, however, it has generally been believed that menstruation was brought about by the ripening of the graafian follicle, and for years it was held that the two processes occurred almost, if not quite, simultaneously.

This doctrine culminated in 1865 with the appearance of Pflüger's article, in which he stated that the menstrual flow resulted from a reflex stimulation, which owed its origin to the pressure exerted by the growing follicle upon the nerves of the ovary. This theory obtained almost immediate acceptance, and upon it was based our method of calculating the expected date of confinement, the rule being to date the beginning of pregnancy from the first day of the last menstrual period.

Pflüger's theory, however, was somewhat shaken by the work of Leopold and his coworkers, whose careful studies of the condition of ovaries removed at operation proved conclusively that the two processes were not necessarily synchronous, and accordingly ovulation could not be considered the unvarying cause of menstruation. Clinical experience also lent further probability to this view, since it has shown that ovulation and subsequent pregnancy may take place without menstruation; as is demonstrated by the instances of conception occurring before the establishment of menstruation or after the menopause, as well as during lactation, when the menstrual flow is usually absent. Moreover, cases are recorded in which pregnancies had followed in such rapid succession that menstruation did not occur for years.

Sigismund, Löwenhardt, Löwenthal, and Aveling next advocated the theory that ovulation preceded menstruation, and that the latter was due to the failure of conception. Aveling designated the process as nidation and denidation, and considered that a *menstrual decidua* was formed each month for the reception of the fertilized ovum, and that if conception did not occur it degenerated and was cast off with the menstrual flow. The gist of these theories was tersely expressed by Powers in the dictum, "Women menstruate because they do not conceive."

This view was also adopted by His and most embryologists as true for a certain number of cases, at least. They found on examining ova which were of the same age, as estimated from the last menstrual period, that some presented a stage of development several weeks in advance of the others. They held, therefore, that this difference could be explained only by supposing that the former resulted from conception soon after the last menstrual period, and the latter from conception shortly before the first period missed. That ovulation and menstruation are not synchronous is also confirmed by the reproductive history of orthodox Jewesses, who are noted for their fertility. According to the Mosaic law women are considered unclean during the entire menstrual period and the seven days following it, so that in them conception must occur after that time. This view also receives support from my experience that practically three-fifths of the women who marry in the middle of an intermenstrual period, and who miss the succeeding flow, are delivered of children of normal size two hundred eighty days after the onset of the last period, or in less than nine calendar months after marriage. Somewhat similar conclusions were drawn by Siegel and others, who during the World War studied a series of German women who had conceived following the return home of the husband on a short furlough, although striking exceptions were sometimes noted.

Fränkel, in 1910, concluded that ovulation usually occurs nineteen days after the first day of the last period; as he held that the corpus luteum resulting from the rupture of that follicle attains its highest development during the week following it, when, if conception does not occur, it undergoes rapid degeneration, and gives rise to menstruation. This belief was further elaborated by the work of Halban, Meyer, Ruge, and R. Schroeder, in which the cyclical changes of the endometrium were studied in association with the development of the corpus luteum. As a result, these investigators concluded that ovulation usually occurs in the later days of the second week following the beginning of the last period, and is immediately followed by the rapid development of the corpus luteum, which attains its highest perfection ten or twelve days later. If fertilization takes place, the corpus luteum persists practically unchanged for months, when its secretion plays an important part in the woman's economy and probably regulates the implantation of the ovum. Whereas, if conception and implantation do not occur the corpus luteum promptly shows degenerative changes, which in turn lead to the onset of the menstrual flow. Or, to use Meyer's terse expression—"without ovulation no formation of corpus luteum, and without the latter no menstruation."

That ovulation in women usually occurs about this time has been conclusively demonstrated by Allen and his associates, who in 1928 were able to recover normal ova from the fallopian tubes of six women at periods varying from twelve to sixteen days after the onset of the last menstruation.

Accordingly, we now believe that the proliferation of the endometrium is the result of hormonic influences originating in the growing follicle, that rupture occurs somewhere about the middle of the intermenstrual period, so that when the fertilized ovum reaches the uterine cavity some days later it finds the pregravid endometrium ready for its implantation and nutrition. On the other hand, if fertilization does not occur menstruation recurs twelve or fourteen days after the follicle has ruptured, and is preceded by degenerative changes in the corpus luteum; but whether the actual flow is the result of such changes, or merely represents nature's method of getting rid of tissue which has served its purpose, is yet to be proved. The figures just mentioned should not be regarded as absolute, as there is evidence that under certain conditions ovulation may occur at any time. Indeed, this has happened so frequently in the experience of Schickele that he is unable to regard it as a cyclic process. Notwithstanding such exceptions, the present view concerning the relations between ovulation and menstruation indicates that the optimum time for the occurrence of conception is about the middle of the intermenstrual period, and not just before or just after the flow, as is generally believed. In any event, the old teaching that menstruation and ovulation are synchronous must be abandoned.

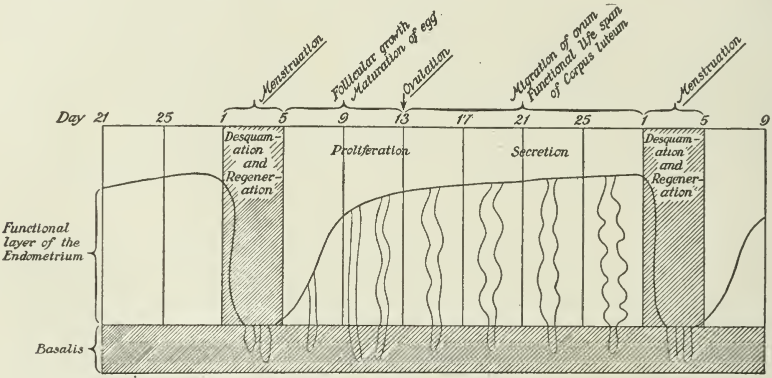

Menstruation
Follicular growth
Maturation of egg
Ovulation
Migration of ovum
Functional life span
of Corpus luteum
Menstruation
Day 21
25
1
5
9
13
17
21
25
1
5
9
Desquam-ation and Regener-ation
Proliferation
Secretion
Desquam-ation and Regener-ation
Functional layer of the Endometrium
Basalis

Fig. 88.—Diagram Illustrating Menstrual Cycle (Evans).

The results following various operations upon the genital tract show that menstruation is dependent upon the presence of the ovaries, but that ovulation may take place without the presence of the uterus. It is generally admitted that the complete removal of both ovaries, which necessarily stops ovulation, is always associated with cessation of the menses. On the other hand, the total removal of the uterus, while necessarily associated with abolition of the menstrual flow, exerts no effect upon ovulation, as is manifested by the regular occurrence of the so-called *menstrual molimina.*

A number of observers have attempted to show that menstruation may occur independently of ovulation, basing their contention upon the occasional continuance of menstruation after the removal of the ovaries. This conclusion, however, is fallacious, as in such cases either the ovaries had not been completely removed, or an accessory ovary was present. The now well-established fact that a very small portion of ovary will suffice for ovulation has been demonstrated by the occurrence, in rare instances, of pregnancy after the supposed removal of both ovaries by competent operators, cases of which have been reported by Gordon, Meredith, and others. The only experimental evidence along such lines which deserves consideration was adduced by Corner, who found that in about one-half of his macacus monkeys, which presented cyclic uterine bleeding, there was no trace of ovulation; while in the other half ova could be found in the tubes and premenstrual changes in the uterus. Whether the bleeding in the first group of cases should be regarded as true menstruation is open to question, but in any event it does not invalidate the conclusions given above.

Mary Putnam Jacobi, in 1876, advanced the so-called menstrual wave theory, which has been accepted by Stephenson, Webster, Ott, Van de Velde, and others. According to this idea, the metabolic processes in women present a distinct rhythm, and gradually increase in intensity up to the time of the menstrual flow, when they suddenly drop and reach their lowest point; after this they gradually rise again to attain their maximum intensity just before the next period, thus indicating that the entire process is under some central control, and is dependent upon some general and as yet unknown cause.

Except for the cyclical changes noted in the tubal epithelium by Snyder, and Novak and Everett, there is no evidence that the normal fallopian tubes take any part in the menstrual function. Jägerroos is doubtless correct in stating that when blood is noted in the tubes at that time it is the result of inflammatory disease, and in no way connected with menstruation.

In the section on the vagina, attention has been directed to the cyclical changes taking place in that organ, which, while characteristic, are nothing like so striking as those occurring during the œstrus cycle of experimental animals.

Migration of the Ovum.—The mechanism by which the ovum gains access to the tube after escaping from the ruptured follicle is a question of extreme interest, and one which has given rise to a great deal of discussion, and has been exhaustively studied in the rabbit by Westman. The process is readily understood in those animals in which the ovaries are completely inclosed in a peritoneal sac into which the tube opens; but in women, and in animals in which the ovary projects freely into the peritoneal cavity, the question presents greater difficulties and has not as yet received a thoroughly satisfactory solution.

As we have already shown, the fimbriated extremity of the tube lies in the neighborhood of the ovary, but is not necessarily in direct contact with it, the only organic connection between the two structures being furnished by the *fimbria ovarica,* which is attached to the upper or tubal pole of the ovary.

Numerous theories have been advanced to explain the manner in which the ovum enters the tube. Rouget believed that the latter became engorged with blood at the menstrual period, and that, as a result of its becoming erectile, the fimbriæ applied themselves to the portion of the ovary in which the ripe follicle was situated—so that, after its rupture, the ovum was immediately taken up by the fimbriated extremity of the tube. This view, however, has been abandoned, as it is difficult to suppose that the tube could instinctively pick out the exact portion of the ovary to which it should apply itself. Kehrer believed that the ovum was ejected from the follicle at the time of rupture with sufficient force to be thrown directly into the fimbriated end of the tube. This, the so-called ejaculation theory, for a time enjoyed considerable vogue, but has likewise been abandoned.

At present it is generally believed that the cilia upon the fimbriated end of the tube give rise to a current in the capillary layer of fluid which lies between the various pelvic organs, so that the ovum, on escaping from the follicle, is taken up by the current and wafted toward one or the other tube, whence it is carried to the uterus. The correctness of this view has been substantiated by the experimental work of Pinner, Jani, and Lode. The former injected cinnabar and the latter the ova of ascarides into the peritoneal cavity of animals, and found that they made their way to the pelvis, where they were taken up by the tubes, through which they were carried to the uterus, and eventually appeared in the vagina. It is more than likely, however, that considerable proportion of the ova which escape from ruptured follicles fail to gain access to the tubes, and perish in the peritoneal cavity.

After the ovum has gained access to the tube its transit to the uterus is effected in part by the ciliary current and in part by contraction of the tubal musculature, and investigators differ as to which of the two plays the major part. In general, the movement is not rapid, and it is generally assumed that the ovum does not reach the uterine cavity until five to seven days after fertilization.

In 1844, Bischoff directed attention to the fact that in animals possessing bicornuate uteri one frequently finds that the corpora lutea are in one ovary, while the embryos are developed in the uterine horn on the opposite side. He supposed in such cases that the fertilized ova had come from the ovary in which the corpora lutea were found, and had made their way into the cornu of the opposite side, instead of into the one corresponding to the ovary from which they came. This process he designated as *migration of the ovum.*

The possibility of such an occurrence in women was first carefully studied by Kussmaul, who stated that it might be brought about in two ways: either by the ovum making a circuit through the pelvic cavity and thus gaining access to the opposite tube, or passing down one tube, traversing the uterine cavity, and then making its way up the opposite tube. The former he designated as external, the latter as internal, migration of the ovum.

External migration of the ovum is frequently observed, whereas there is grave doubt as to the possibility of the occurrence of internal migration in women. We are unable to ascertain how frequently external migration takes place in normal uterine pregnancies, though it is probably much more common than is generally believed. Its occurrence has been repeatedly demonstrated in cases of bicornuate uteri, and in those presenting a rudimentary horn; and frequently in normal uteri, when the fimbriated extremity of one tube is occluded, as in cases of hydrosalpinx or inflammatory lesions, while that of the other tube is patent.

External migration of the ovum has been produced experimentally in animals by Leopold, who excised one ovary and the opposite tube, and in a number of such cases the animals became pregnant after the operation. A very convincing case has been reported by Kelly, who removed the diseased left ovary and right tube from a patient, leaving the normal right ovary and left tube behind. Fifteen months later she was delivered at term, and seventeen months subsequently the remaining tube was removed for a ruptured extra-uterine pregnancy.

In numerous specimens of extra-uterine pregnancy, I have found incontrovertible evidence of external migration of the ovum, the corpus luteum being in the ovary of one side and the pregnancy in the opposite tube. The phenomenon was beautifully exemplified in a specimen which I examined for H. C. Coe. In this case the right tube had twice been the seat of extra-uterine pregnancy. The first pregnancy, which dated from several years before, was situated in the isthmic portion of the tube, the fœtus having become converted into a lithopedion which completely blocked the lumen. External to this, and occupying the lateral portion of the tube, was a freshly ruptured four months' pregnancy. The corresponding ovary was small, atrophic, covered by adhesions; the opposite one contained the corpus luteum of pregnancy. Apparently in this case the ovum must have been fertilized, soon after leaving the left ovary, by a spermatozoön which had made its way up the left tube; after which it had been carried to the right tube and had passed down it until arrested by the lithopedion, when it underwent further development.

Allen and his associates have adduced conclusive evidence of the occurrence of external migration in normal genitalia by finding an ovum in the right tube twelve days after the onset of the last period, while the corpus luteum was situated in the left ovary.

While no satisfactory evidence in favor of the occurrence of internal migration has been adduced for women, Corner has demonstrated its occurrence in sows, by showing that the number of embryos in the two horns of the uterus is not the same as the number of corpora lutea in the corresponding ovary. For example, if four embryos are found in either horn, while the right ovary contains 2 and the left 6 corpora lutea, he assumes that the right horn originally contained 2 and the left horn 6 embryos, but that as they grew larger 2 embryos were forced mechanically from the left to the right horn.

Place of Meeting of the Ovum and Spermatozoa.—During coitus the semen is deposited in the vagina, and the question arises, How do the spermatozoa contained in it make their way into the uterus, and when and where do they come in contact with the ovum?

The number of spermatozoa contained in a single ejaculation has been estimated by Lode at 226,257,900. Some idea of Nature's generosity in this respect may be gained by realizing how relatively few ejaculations are necessary to produce sufficient spermatozoa to equal the four billion cells which it is calculated make up the entire body. Various explanations of the method by which they gain access to the uterine cavity have been advanced, the most widely known being the aspiration theory of Litzmann, Wernich, and Beck, and the mucus-plug theory of Kristeller. The first-mentioned observers held that the external muscles of the uterus contract forcibly during coitus and compress the uterine cavity, into which the spermatoza are aspirated when relaxation occurs. Kristeller believed that at the height of the orgasm the thick tenacious mucus, which is usually found in the cervix, is forced down for a short distance into the vagina, where it becomes covered with spermatozoa, after which it returns to its original position and carries them with it.

It cannot be denied that spermatozoa may gain access to the uterine cavity in either of these ways in a certain number of cases; but in the majority of instances it is probable that they make their way thither by their own activity. Moreover, the observations of Löw indicate that the mucous secretion of the uterus possesses a positive attraction for them, as can be verified under the microscope. That this view is correct is demonstrated by the instances of pregnancy following imperfect coitus, and particularly those which have been observed in women with unruptured hymens. Furthermore, it has been shown by Henle that spermatozoa can move at quite a rapid rate, being able to travel a distance of 1 centimeter in three minutes.

It was formerly taught that *impregnation* normally occurred in the uterine cavity, and it was believed by Tait, Wyder, and other observers that conjugation was favored by the direction of the currents produced by the cilia of the uterus and the tubes, the former being directed from below upward, and the latter from above downward, so that the two met in the upper part of the uterine cavity. Thus, the ciliary current would favor the entrance of spermatozoa into the uterus, while rendering impossible their entry into the tubes, except in diseased conditions. But in view of the observations of Hofmeier, Mandl, and others, which show that the ciliary current is directed from above downward, in the uterus as well as in the tubes, it is apparent that this theory must be abandoned, and it must be admitted that the spermatozoa have to make headway against the current from the time they enter the internal os.

Years ago, Bischoff showed that large numbers of spermatozoa could be found upon the surface of the ovaries of animals within a few hours after copulation, and the occurrence of ovarian pregnancy demonstrates that the same may occur in women. From our knowledge of the sexual history of animals and women, it is now universally admitted that spermatozoa promptly gain access to the tubes and that fertilization usually occurs at their lateral ends. Consequently, practically every pregnancy is primarily tubal, so that the question to be solved is how the fertilized egg gains access to the uterus. It is generally assumed that it is carried down by the ciliary current; but when it is realized how relatively large the egg is in comparison to the free space between the folds of the tubal mucosa, it may well be that muscular peristalsis also plays a part. In any event, the process is slow, being estimated by most authors at seven, and by Grosser at ten days.

Until 1914, it was generally assumed that in married women, who copulate at ordinary intervals, living spermatozoa could always be found in the tubes, into which they had made their way by their own motility. In other words, the tube might be regarded as a species of receptaculum seminis, in which living spermatozoa were always present and waiting for the ovum.

The studies of Hoehne and Behne, however, disturbed this belief, as their experimental work indicated that spermatozoa live a much shorter time in the generative tract than was formerly believed, and perish after a stay of one and a quarter hours in the vagina, and two or three days in the uterus or tubes. If they are correct, coitus must occur within a few days of the time of ovulation if fertilization is to be effected, or else it must be assumed that unfertilized ova can live for days, which appears improbable. Nürnberger, on the other hand, believes in the correctness of the older views, as he claims to have kept human spermatozoa alive in test tubes for seven or eight days, and was able to demonstrate motile spermatozoa in normal fallopian tubes, which had been removed thirteen or fourteen days after the last coitus. Such observations bear out the experience of Birch-Hirschfeld and Dührssen, and are in accord with the well known fact that in the bat spermatozoa retain their activity for months. In view of such conflicting opinions, the question must be regarded as *sub judice,* until further work is available.

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CHAPTER IV

MATURATION, FERTILIZATION, AND DEVELOPMENT OF THE OVUM

In the present work we shall not attempt to trace the development of the ovum through all its stages, but shall consider only those changes which are directly concerned in the formation of the fœtal membranes and the placenta. For detailed information concerning the general development of the embryo the student is referred to the standard works upon embryology.

Maturation of Ovum.—The ovum, as it occurs in the developing graafian follicle, is not adapted for fertilization and further development until it has undergone certain changes, more especially noticeable in its nucleus, which may be regarded as signs of maturation. This consists in the formation and extrusion of the polar bodies, which lead to the reduction in the number of chromosomes to one half of that characteristic of the somatic cells. The process has not as yet been proved for the human ovum, and so far as I can ascertain Corner is the only observer who has described it in any primate. In 1924, he reported finding a macacus ovum in the tube twelve days before the next expected period, which showed that the first polar body had been extruded, while the spindle for the second one was in process of formation. The observations of Arthur Thompson concerning the formation of polar bodies in human ova still within the follicle are regarded as erroneous by competent authorities, more particularly as Hinselmann has failed to find any trace of their formation in any of the hundreds of mature follicles which he has examined.

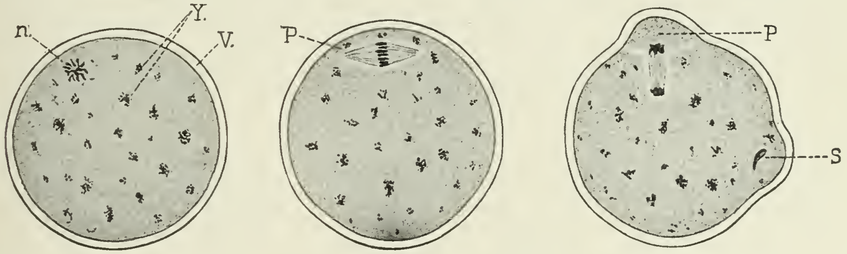


Fig. 89. Fig. 90. Fig. 91.

Figs. 89-91.—Formation of Polar Body (Sobotta). × 500. *n.*, nucleus; *V.*, vitelline membrane; *Y.*, yolk granules; *P.*, polar spindle; *S.*, head of spermatozoön.

On the other hand, Theophilus Painter, Winiwarter and Oguma, and others have conclusively demonstrated that a reducing division occurs in human spermatocytes. In view of these observations, as well as the fact that maturation of the ovum has been observed in all the lower animals which have been studied, it must be assumed that it also occurs in man. The changes are supposed to begin just before the rupture of the follicle, and to be completed while the ovum is in the upper portion of the tube. The process is most readily understood by the study of ova having but few large chromosomes. Accordingly, the egg of the Ascaris megalocephala, which possesses four chromosomes, is well adapted for its demonstration.

Years ago, Sobotta studied the process exhaustively in the mouse, while Van der Stricht's copiously illustrated article, which appeared in 1923, gives authoritative information concerning it in many animals. When the process of maturation is about to begin, the germinal vesicle approaches the surface of the ovum, and appears to become smaller, while at the same time its membrane disappears. It gradually becomes less and less distinct, until finally its situation is indicated by a clear area surrounded by deutoplasm, which is traversed by many radiating lines. In a short time this becomes transformed into a typical caryokinetic or mitotic figure, which undergoes the usual changes and soon becomes spindle-shaped. The spindle, when it first appears, is situated tangentially to the surface of the ovum, but later turns and becomes perpendicular to it. The chromatin of the spindle then becomes rearranged and a typical dyaster is formed (Figs. 89-91). Division rapidly ensues, and the new nucleus nearest the surface, with the portion of protoplasm surrounding it, is cut off from the bulk of the ovum and comes to lie between it and the vitelline membrane. In this way is formed the first *polar body* and the oöcyte of the second order. As the process is a typical cell division, the nucleus of both the polar body and of the oöcyte will contain the typical number of chromosomes.

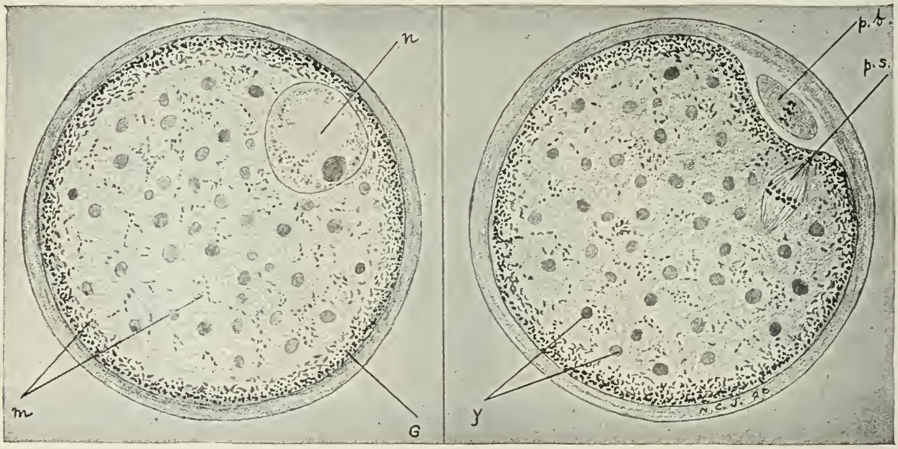


FIG. 92.—DIAGRAM OF MATURING (LEFT) AND MATURE (RIGHT) OVA (CORNER).

G, dispersed golgi apparatus; *m*, mitochondria; *n*, nucleus; *P.b.*, first polar body; *P.s.*, second polar body; *y*, yolk granules. (From Cowdry's "Special Cytology," courtesy of Paul B. Hoeber, Inc.)

Almost immediately a new spindle appears in the oöcyte, and division occurs without preliminary cleavage of the chromosomes, so that two cells are formed, each of which has only one half the number of chromosomes characteristic of the species. The smaller of these is cast off as the second polar body, while the remaining large cell is the mature ovum, whose nucleus is then designated as the female pronucleus.

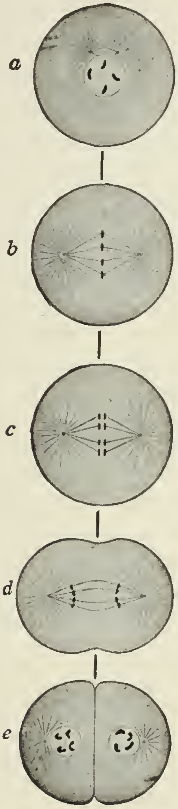


Fig. 93.—Diagram Showing Normal Cell Division with Four Chromosomes.

a, cell with 4 chromosomes; *b,* formation of spindle; *c,* splitting of chromosomes in spindle; *d,* separation of daughter chromosomes; *e,* complete separation into 2 cells, each with 4 chromosomes.

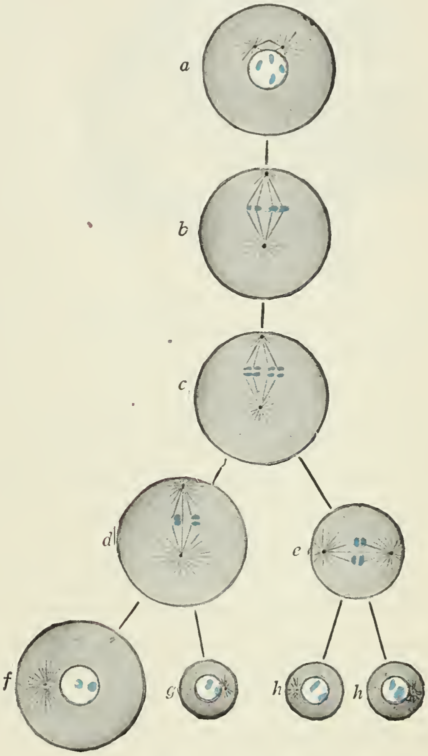


Fig. 94.—Diagram Showing the Reduction in the Number of Chromosomes in the Maturation of the Ovum.

a-b-c, oöcyte of first order in various stages of division; *d,* oöcyte of second order; *e,* first polar body; *f,* mature ovum; *g,* second polar body; *h,* cells derived from division of first polar body.

As the first polar body is formed by typical cell division, it must be regarded as homologous with the oöcyte, from which it differs only by its smaller size. On the other hand, the second polar body is homologous with the mature ovum, and contains only one half the number of chromosomes characteristic of the body cells. Under abnormal conditions it may likewise become fertilized; in which event, according to the theories of Bonnet, Wilms, and Marchand, it may play a part in the production of a teratoma. It would therefore appear that in the process of maturation six cells may develop from the original oöcyte of the first order: by the nonreducing division, the oöcyte of the second order and the first polar body; while by the reducing division the oöcyte gives rise to the mature ovum and the second polar body, and the first polar body to two cells homologous with the second polar body (Fig. 94).

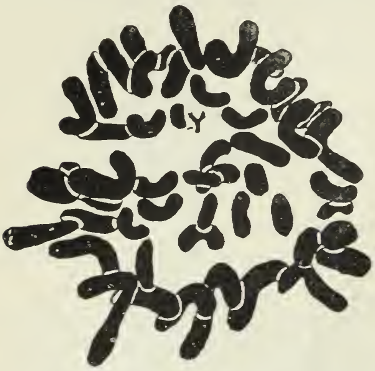


Fig. 95.—Human Spermatogonial Division, with 48 Chromosomes (Painter).

Maturation is essentially a means of reducing the number of chromosomes, though its exact significance is not clear. Following the theory of Weissman, it is generally believed that the object of the reduction is to make possible the introduction of paternal chromosomes into the ovum at the time of fertilization, without increasing the number of chromosomes characteristic of the species, as must inevitably occur were some such mechanism not provided. In any event, the process must be regarded as a necessary preliminary to normal fertilization and further development of the ovum.

Von Winiwarter and Painter differ slightly as to the number of chromosomes in human spermatogonia and spermatocytes of the first order, the former being able to count 47 and the latter 48. Consequently, it must follow, if the first view is correct, that two types of spermatozoa will result, one containing 23 and the other 24 chromosomes, respectively; while if the second view holds, all spermatozoa will contain 24 chromosomes. As it is believed that the mature ovum constantly contains 24 chromosomes, it is evident that following fertilization the number will become restored to 47 or 48 chromosomes, according to the type of spermatozoön effecting fertilization, as will be elaborated in greater detail when the question of the production of sex is studied.

Fertilization.—By fertilization is understood the union of a spermatozoön and a mature ovum. Each *spermatozoön* must be regarded as a distinct cell, and consists of three portions—the head, which contains the nuclear material, the tail, and an intermediate portion. The head is somewhat triangular in shape and flattened from side to side. Interpolated between it and the long tail is a small cylindrical body, the intermediate portion (Fig. 96). The spermatozoa are endowed with marked motility, derived from the rapid vibration of their tails, and, according to Henle, can traverse a distance of 1 centimeter in three minutes.

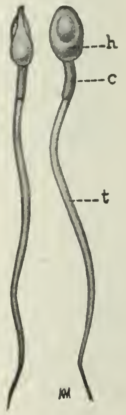


Fig. 96.—Human Spermatozoa. *h*, head; *c*, intermediate portion; *t*, tail.

In spermatogenesis, changes are observed analogous to those occurring in the maturation of the ovum, and it has been clearly shown that each spermatocyte of the first order divides into two cells, each of which in turn gives rise to two others containing only one-half the number of chromosomes characteristic of the species (Fig. 97). These latter are the spermatids, which later become the spermatozoa. Each spermatozoön, therefore, must be regarded as analogous with the mature ovum and the second polar body. Figure 95, from the monograph of Painter, shows that the human spermatocyte contains 48 chromosomes, consequently, if his contention is correct, each spermatozoön must contain 24.

As has already been pointed out, the spermatozoön and ovum usually come together in the lateral portion of the tube, although in rare instances the meeting may take place on the surface of the ovary or even in a graafian follicle, as is demonstrated by the occurrence of ovarian pregnancy.

In the lower animals in which the process of fertilization has been studied, the ovum is found in the lateral end of the tube, surrounded by a considerable number of spermatozoa, as many as 60 having been counted about a single ovum. These rapidly penetrate the vitelline membrane, but it appears that normally only one of them makes its way into the ovum, and that after its entry the superficial portion of the latter becomes impervious to other spermatozoa.

After the head has entered the ovum the tail rapidly disappears, and in a short time nothing is left of the original spermatozoön but a small spindle-shaped mass, the *male pronucleus* (Fig. 92). This rapidly makes its way to the center of the ovum, where it meets and fuses with the female pronucleus to form the segmentation nucleus.

As the male and female pronuclei each contain one half the number of chromosomes characteristic of the species, their union restores the normal number (Fig. 98). Thus, in ascaris, two of the chromosomes of the segmentation nucleus are of paternal and two of maternal origin, while in man 24 come from each cell. Moreover, as the chromosomes of both the mature ovum and the spermatozoön are the direct descendants of those concerned in the fertilization of the parent organisms, it is apparent that the process does not consist merely in the union of so many paternal and maternal chromosomes, but has a much broader significance, in that it brings together nuclear substances derived from the ancestors of both parents, and thus affords a basis for a comprehensible theory of heredity. Consequently, in the case of man, in which the fertilized ovum contains 48 chromosomes, it is apparent that an almost endless number of combinations are possible.

Ordinarily, segmentation does not begin until after fertilization, but it is well known that in many insects it is not dependent upon the fusion of the male and female elements, as normal individuals may develop from unfertilized ova—parthenogenesis. Moreover, it has been repeatedly shown that segmentation may be inaugurated in various animals without the presence of spermatozoa by subjecting the mature ovum to the action of various chemical agents, such as weak solutions of acids or alkalis—artificial parthenogenesis. In such cases development appears to progress normally up to a certain point, but at present there is no evidence available to indicate that thoroughly formed animals will result.

It is now generally admitted that in such circumstances the egg casts off two polar bodies, as usual, so that the cells resulting from its segmentation will possess only one half as many chromosomes as when fertilization occurs.

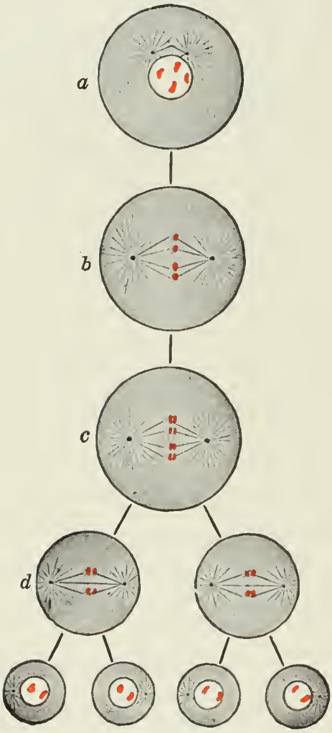


Fig. 97.—Diagram Showing the Reduction in the Number of Chromosomes in Spermatogenesis in a Species with Four Chromosomes in Somatic Cells.

a-b-c, spermatocyte of first order in various stages of division; *d,* spermatocytes of second order; *e,* spermatids with two chromosomes each.

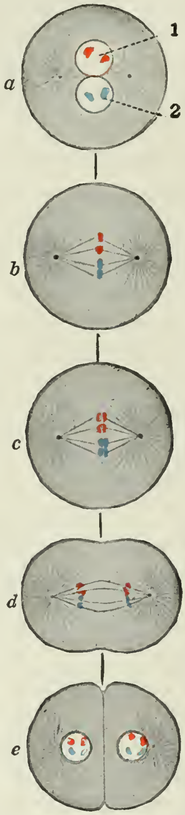


Fig. 98.—Diagram Showing Fertilization and Segmentation of the Ovum.

a, fertilization; 1, male pronucleus; 2, female pronucleus; *b-c,* formation of spindle with chromosomes derived from both ovum and spermatozoön; *d-e,* cell division showing perpetuation of paternal and maternal chromosomes in body cells.

Accordingly, it would appear that the process of fertilization may be resolved into two parts—the fusion of the male and female chromosomes, and the inauguration of segmentation. In the higher animals it would seem that the two functions are inseparable, while experiments upon artificial parthenogenesis in some of the lower species indicate that the latter may occur independently of the former. In view of such facts, Loeb, in 1909, stated that the spermatozoön may be regarded as an activator which serves to stimulate nuclein synthesis.

For a time it was believed that the centrosome—the structure which apparently presides over the act of cell division—disappeared from the ovum during the last phases of maturation, and accordingly the mature ova could not begin to segment until the lacking structure had been restored by means of the male pronucleus. This, however, cannot be accepted as a universal rule, particularly in view of the fact that such a possibility is lacking in artificial parthenogenesis.

General Development of Ovum.—Soon after the appearance of the segmentation nucleus, caryokinetic changes take place within it and give rise to a typical nuclear spindle, which is soon converted into a dyaster, to be speedily followed by the division of the ovum into two cells (Figs. 99-101). Each of these in turn divides, giving rise to four cells, though Sobotta's investigations on the mouse show that one of the original cells divides earlier than the other, so that we next have three cells. This process of cell division or segmentation goes on until the original ovum becomes converted into a mass of cells, which is designated as the *morula,* or *mulberry mass* (Fig. 104).

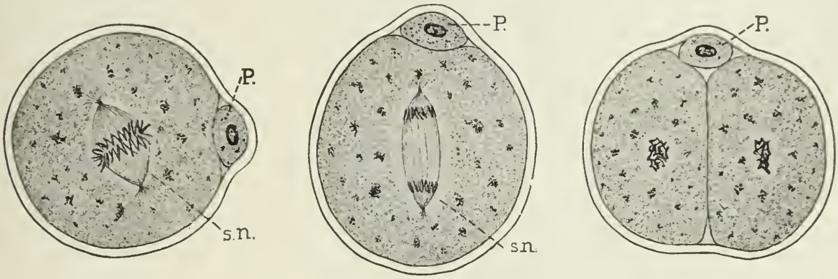


Fig. 99. Fig. 100. Fig. 101.

Figs. 99-101.—Changes in the Segmentation Nucleus (Sobotta). × 500. *P.,* polar body; *s.n.,* segmentation nucleus.

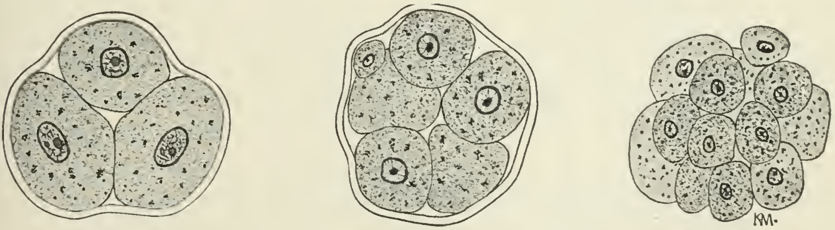


Fig. 102. Fig. 103. Fig. 104.

Figs. 102-104.—Formation of Mulberry Mass (Sobotta). × 500.

Fluid soon appears in the interior of the mulberry mass and forces the cells to the periphery, thus giving rise to a vesicular structure consisting of a single layer of cells which surround a cavity filled with fluid—the segmentation cavity. The entire structure at this time is known as the *blastodermic vesicle,* which in the rabbit and many other animals is still surrounded by the vitelline membrane (Fig. 105), whereas in the mouse the latter disappears before the formation of the mulberry mass.

In a short time a collection of several layers of cells can be noted at one point on the inner surface of the blastodermic vesicle. This is known as the *internal cell mass,* while the single layer of cells forming the wall of the vesicle is frequently spoken of as the primitive chorion. As the result of improved methods of washing out ova from the tubes, this process has been demonstrated in large numbers of animals, and it is interesting to note that Warren H. Lewis, in 1928, succeeded in demonstrating it by tissue-culture methods in the case of the rabbit, and consequently was able to demonstrate the process by means of moving pictures.

When viewed by transmitted light the internal cell mass appears darker than the rest of the surface of the blastodermic vesicle, and hence is called the *macula embryonalis.* Sections made through it at this point show that it is composed of several layers of cells, those nearest the exterior being ectodermal; those nearest the segmentation cavity entodermal in character.

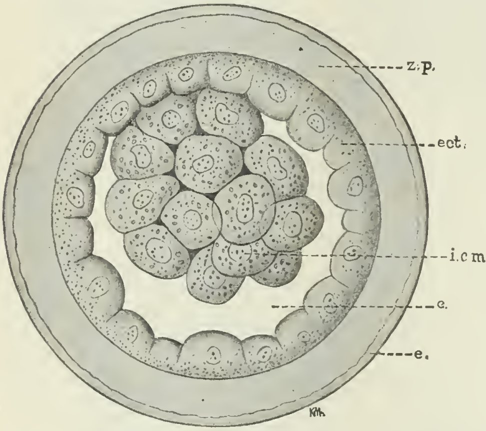


Fig. 105.—Blastodermic Vesicle of Rabbit (von Beneden).
c., cavity of vesicle; *ect.,* primitive ectoderm; *i.c.m.,* internal cell mass; *z.p.,* zona pellucida; *e.,* albuminous envelope.

The formation of a blastodermic vesicle has not as yet been observed in the human ovum, but, as it has been demonstrated in the ova of every species of animal which has been available for study, there is no doubt that it occurs in all mammals. These changes are supposed to take place while the ovum is making its way through the tubes, or just after it has become implanted upon the uterine mucosa. Since the studies of Graf Spee show that in the guinea-pig the blastodermic vesicle is not formed until after the ovum has become imbedded in the decidua, it is probable that the same holds good for man. The transit through the fallopian tube is believed to occupy a period of from three to seven days, as has been verified in the guinea-pig, and appears probable in human beings.

Following the formation of the blastodermic vesicle and its internal cell mass, the further development of the ovum varies according to the intimacy of its attachment to the uterine wall. If it merely adheres to the surface of the decidua, as in the rabbit or dog, and there is an abundance of space in the uterine cavity, important changes connected with the development of the embryo and its enveloping membranes promptly occur upon the surface of the vesicle. On the other hand, if the ovum is very minute and is buried in the depths of the uterine mucosa, these changes are lacking, and further development takes place in the interior of the vesicle—the so-called "inversion" of the germ layers, to which attention was particularly directed by Selenka, in 1884. At first this was considered peculiar to certain rodents, but it is now known to occur in many other mammals, and in all probability a somewhat similar process occurs in man. We shall accordingly briefly consider the changes occurring in the rabbit and dog, and then take up in more detail those observed in man. In the first mentioned animals, the cells composing the internal cell mass proliferate, and soon give rise to a round or oval area at one point on the surface of the blastodermic vesicle—the *embryonic area,* which at first consists of two layers of cells representing the ectoderm and entoderm, respectively. The embryonic area, when viewed by transmitted light, is first round, but later oval in shape, and presents a dark center and a light periphery, which are designated respectively as the *area opaca* and the *area pellucida* (Fig. 106). This differentiation is due to the fact that the cells composing the former are arranged in several layers, whereas in the latter only two can be made out.

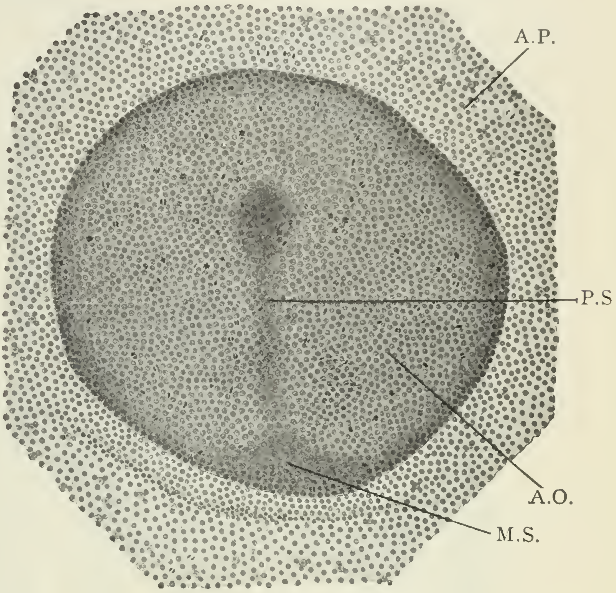


FIG. 106.—EMBRYONIC AREA, DOG (Bonnet). × 90. *A.O.*, area opaca; *A.P.*, area pellucida; *M.S.*, mesodermic sickel; *P.S.*, primitive streak.

The embryonic area soon becomes slightly elevated above the general surface of the blastodermic vesicle, and now forms what is known as the *embryonic shield.* A few hours later a darker zone appears at one end of the shield and soon exceeds it in size (Fig. 106, *M.S.*). This is the *mesodermic area,* which on section is seen to be made up of spindle-shaped and triangular cells. This area rapidly increases in size, and soon forms a complete layer inside the blastodermic vesicle between the ectoderm and entoderm.

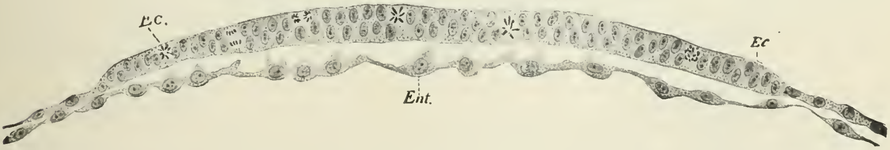


FIG. 107.—SECTION THROUGH EARLY EMBRYONIC AREA OF DOG (Bonnet). × 180. *Ec.,* ectoderm; *Ent.,* entoderm.

A little later there appears in the middle of the embryonic area a slight depression—the *primitive streak*—which is bounded on either side by a slight elevation—the *primitive folds* (Fig. 108). Shortly afterward a second depression —the *medullary groove*—appears in front of the primitive streak. It is bounded on either side by an elevated fold—the medullary ridges—which converge anteriorly to form the headfolds. The medullary groove is in the same line with the primitive streak, but never unites with it; while the medullary folds diverge posteriorly and inclose the anterior end of the primitive streak. As the ovum becomes older, the medullary groove and folds, which result from proliferation of the ectoderm and later give rise to the central nervous system, rapidly increase in size; while the primitive streak remains stationary, so that in a short time it occupies only an insignificant portion of the embryonic area.

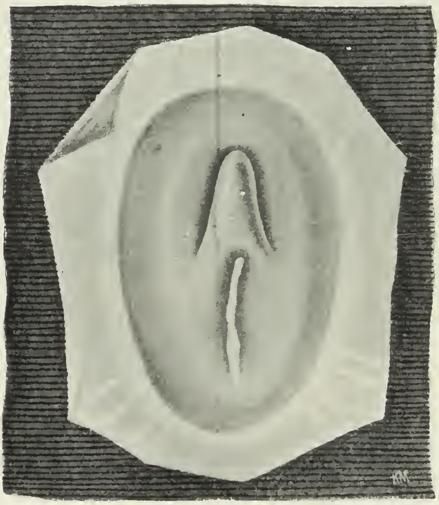


Fig. 108.—Embryonic Shield of Rabbit, Showing Primitive Streak and Medullary Folds (Kollmann). × 28.

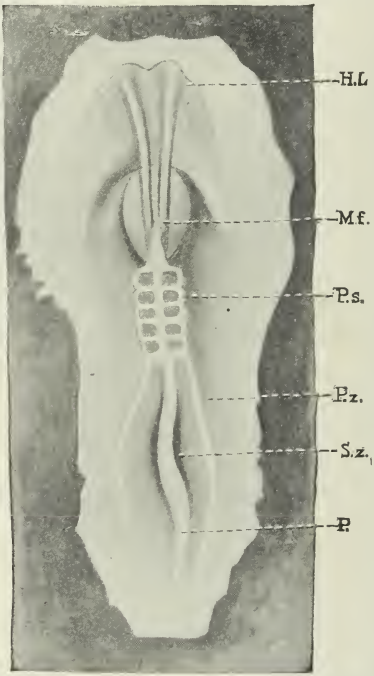


Fig. 109.—Chicken Embryo with Five Segments (Kollmann).

H.f., head fold; *M.f.*, medullary folds; *P.*, primitive streak; *P.s.*, primitive segments; *P.z.*, parietal zone; *S.z.*, segmental zone.

While these changes are taking place on the surface of the embryonic area, others of no less importance are going on in its depths, which result in the formation of the mesodermic structures. On either side of the medullary canal can be observed a slight thickening—the segmental layer, outside of which is a thinner layer—the parietal zone (Fig. 109). The segmental layer soon becomes divided up into a number of more or less cuboidal masses of tissue on either side of the medullary groove, which are variously designated as *protovertebræ,* primary segments, or mesoblastic somites; from these the musculature of the dorsal portion of the body is developed. The parietal zone, which is also made up of mesoderm, soon becomes divided into two layers which inclose a cavity, the cœlom. The outer layer is covered by ectoderm, and is designated as the *somatopleure,* while the inner is lined by entoderm and is called the *splanchnopleure.* From a part of the former the anterior and lateral abdominal walls are developed, while in many animals its greater portion gives rise to the chorion and amnion (Fig. 114).

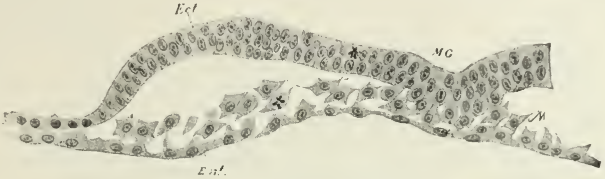


Fig. 110.—Section through Embryonic Area of Dog Showing Three Germ Layers (Bonnet). × 180.
Ect., ectoderm; *Ent.,* entoderm; *M.,* mesoderm; *M.G.,* medullary groove.

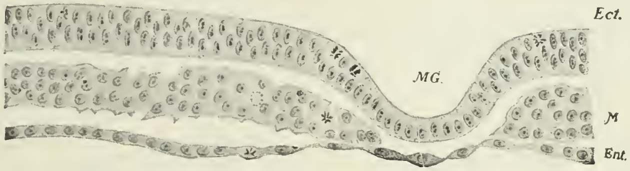


Fig. 111.—Section through Dog Embryo Showing Greater Development of Mesoderm (Bonnet). × 180.
Ect., ectoderm; *Ent.,* entoderm; *M.,* mesoderm; *M.G.,* medullary groove.

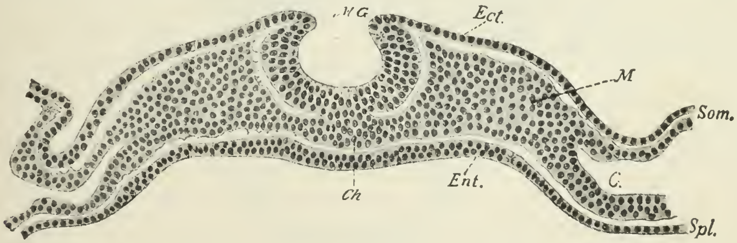


Fig. 112.—Section through Dog Embryo Showing Formation of Amnion (Bonnet). × 100.
C., cœlom; *Ch.,* notochord; *Ect.,* ectoderm; *Ent.,* entoderm; *M.,* mesoderm; *Som.,* somatopleure; *Spl.,* splanchnopleure; *M.G.,* medullary groove.

Thus far we have considered the growing ovum as seen from without; but the study of microscopical sections through it aids us still further in understanding its development. Figure 107 represents a section through the embryonic area at an early period, and shows that the greater part of the blastodermic vesicle is composed of two layers of cells, the *ectoderm* and the *entoderm,* while in the region of the embryonic area the former is arranged in several layers, whereas the latter consists of only a single one. Figure 110 represents a section through the embryonic area of a dog at a little later stage, and shows three distinct layers—ectoderm, mesoderm, and entoderm. In Figure 112 a still later period of development is shown; the medullary groove is well marked, and the mesoderm has become thickened to form the segmental layer, lateral to which is the parietal zone, which has already split, giving rise to the mesodermic portion of the somatopleure and splanchnopleure.

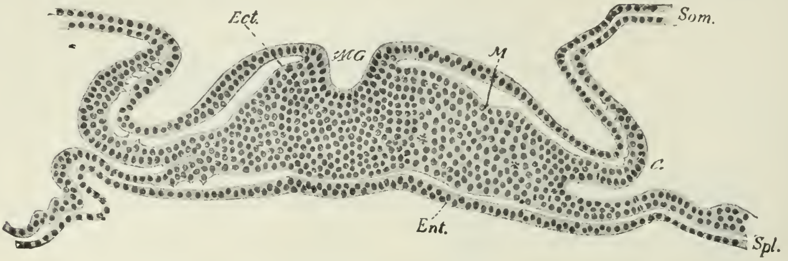


Fig. 113.—Section through Dog Embryo Showing Formation of Amnion, with Greater Development of Somatopleure (Bonnet). × 100.
C., cœlom; *Ch.,* notochord; *Ect.,* ectoderm; *Ent.,* entoderm; *M.,* mesoderm; *Som.,* somatopleure; *Spl.,* splanchnopleure; *M.G.,* medullary groove.

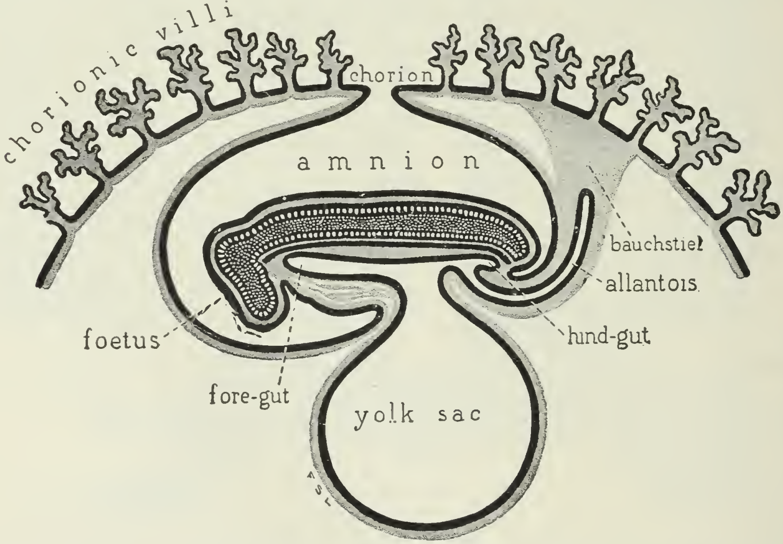


Fig. 114.—Diagram Representing Longitudinal Section through Mammalian Embryo, Showing Formation of Amnion.

From the ectoderm are developed the central nervous system and the cutaneous structures; from the mesoderm are derived the muscular and circulatory portions of the body, the reproductive organs and the connective-tissue framework of the various other organs; while the entoderm gives rise to the digestive tract and the organs which are more or less intimately connected with it.

In the chicken, rabbit, dog, and many other mammals the *chorion* and *amnion* are not formed until the embryo has assumed definite proportions, and the parietal layer of the mesoderm has become well developed and, together with the ectoderm and entoderm, has been differentiated into the somatopleure and splanchnopleure (Figs. 112 to 114). Then folds of somatopleure arise at the head and tail ends and sides of the embryo and, gradually arching over it, meet together and fuse, thus inclosing its dorsal surface within two membranes. The outer of these, the *chorion,* is composed of an outer layer of ectoderm and an inner layer of mesoderm; while in the inner membrane, or *amnion,* the mesoderm is without and the ectoderm within, toward the embryo.

Implantation of the Human Ovum.—As has already been indicated, the human ovum has not as yet been observed during the process of segmentation nor in the earliest stages of implantation. Arguing by analogy, Grosser and Teacher suppose that it reaches the uterine cavity and becomes implanted upon its lining membrane between the seventh and tenth day after fertilization. At that time it is probably still in the morula stage; and, as the cells composing it have become progressively smaller with each division, it is assumed that it scarcely exceeds the mature ovum in size—namely, 0.2 millimeter or 1/125 inch in diameter (Figs. 1 to 3, Plate IV, *A*).

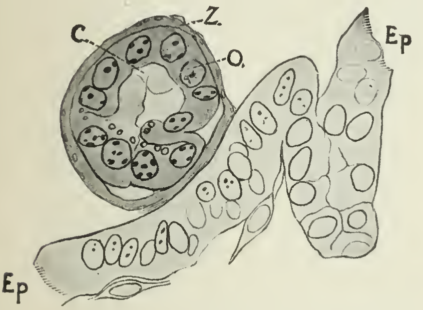


Fig. 115.—Guinea-pig's Ovum Attached to Uterine Mucosa, Seventh Day (Spee). × 375.

C., segmentation cavity; *Ep.,* uterine epithelium; *O.,* ovum; *Z.,* zona pellucida.

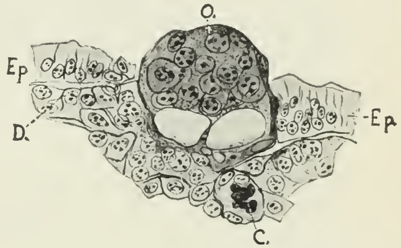


Fig. 116.—Ovum of Guinea-pig Burrowing through Uterine Mucosa, Seventh Day (Spee). × 375.

C., capillary; *D.,* decidua; *Ep.,* uterine epithelium; *O.,* ovum.

These, however, are mere suppositions; but, as the youngest ova with which we are acquainted are already completely imbedded in the superficial part of the decidua, we are forced by analogy to believe that implantation is effected in somewhat the same manner as in the guinea-pig. Graf Spee has demonstrated that the ovum of that animal reaches the uterus during the seventh day after fertilization while still in the morula stage, when, owing to the viscidity of its exterior, it becomes attached to the free surface of the endometrium. As a result of a supposed digestive action, the epithelium directly beneath it is destroyed and the stroma liquefied, so that the ovum gradually sinks into the decidua and comes to lie well beneath its surface. Following this the margins of the opening coalesce, so that the ovum is eventually buried in the decidua, and has no communication with the uterine cavity (Figs. 115-117 and Figs. 4, 5 and 6 Plate IV, *A*).

Such a procedure does not imply so radical a destruction of tissue as one might suppose, since it involves an area only the width of a few epithelial cells. Moreover, the digestive action is not entirely hypothetical, as Gräfenburg has demonstrated that human fœtal ectoderm contains a tryptic ferment, which is capable of digesting culture media in laboratory experiments.

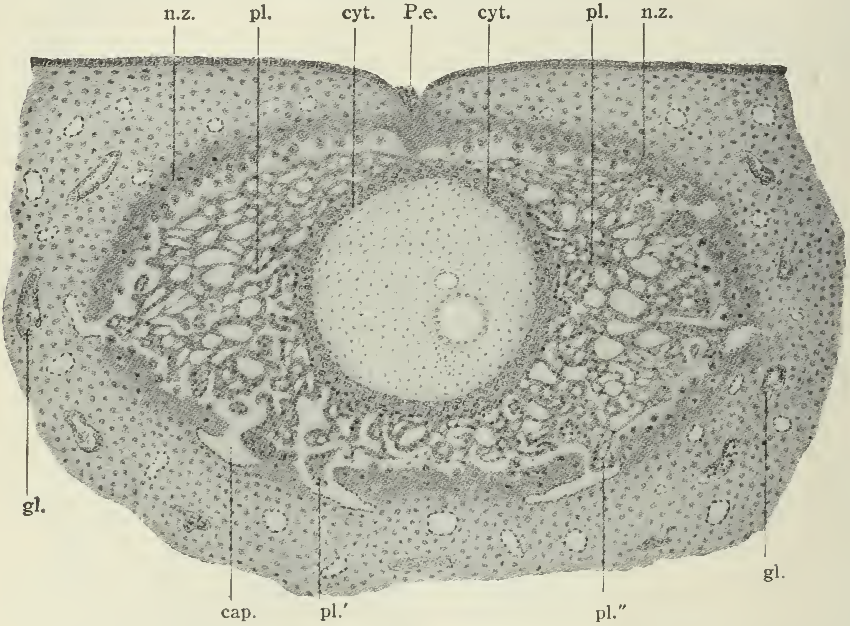
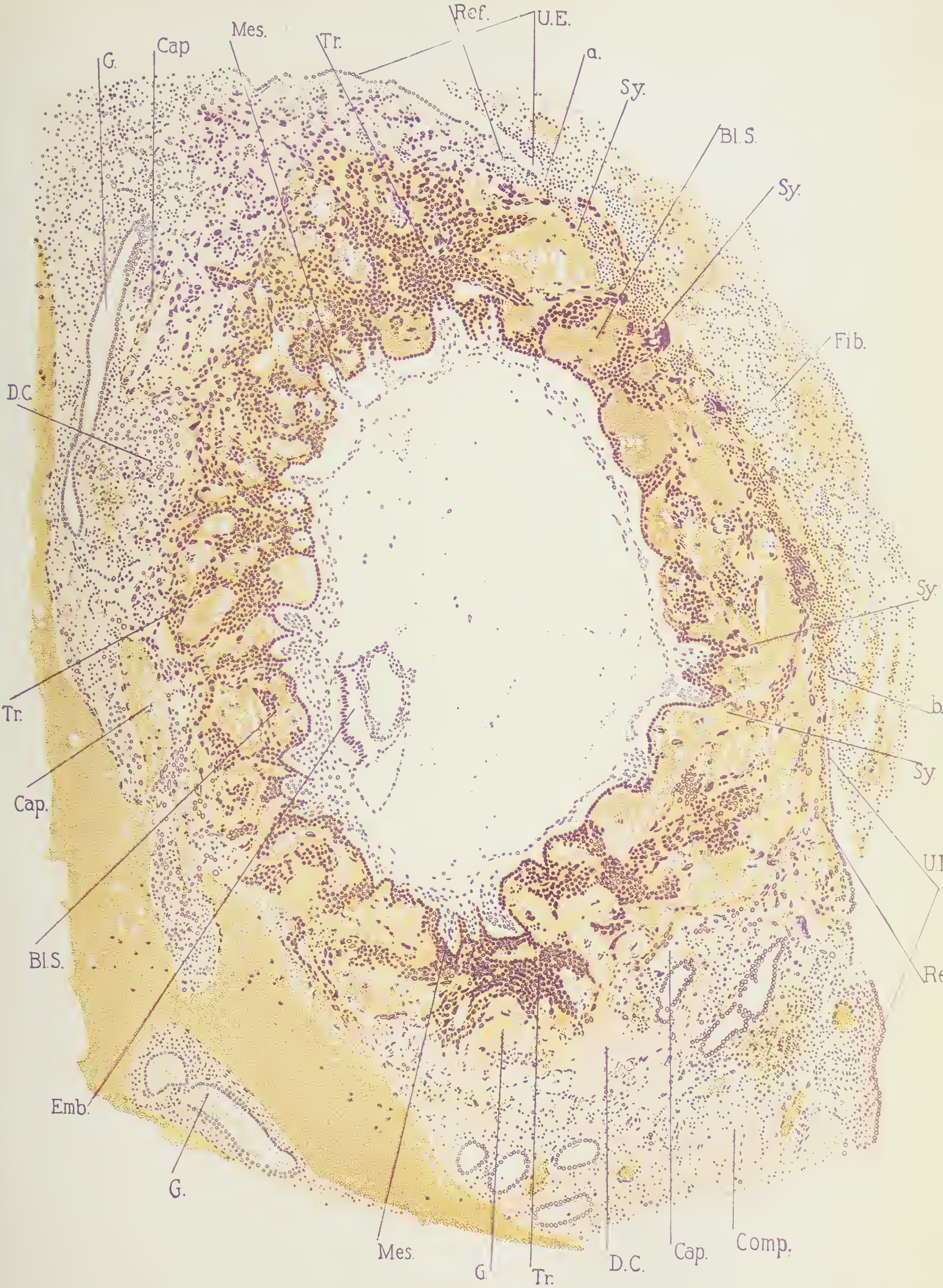


Fig. 117.—Diagram of Teacher-Bryce Ovum. × 50. (T. H. Bryce, Del.)
P.e., point of entrance; *cyt.*, cytotrophoblast; *pl.*, plasmoditrophoblast; *n.z.*, necrotic zone of decidua; *gl.*, gland; *cap.*, capillary; *pl.'*, masses of vacuolated plasmodium invading capillaries. The cavity of the blastocyst is completely filled with mesoblast, and imbedded therein are two cavities, the larger one representing the amnio-embryonic vesicle, and the smaller one the yolk sac.

Formerly, it was believed that in women the ovum was implanted upon the free surface of the endometrium, which had become transformed into a decidua for its reception, and eventually became cut off from the uterine cavity by an encapsulating upgrowth of the adjacent tissue—the decidua capsularis; but, as early as 1896, Herff stated that it probably became implanted by a mechanism similar to that observed in the guinea-pig. Such views, however, were not seriously considered until 1899, when Peters described a very early ovum in situ (Plate IV). As this was deeply imbedded in the decidua and was completely separated from the uterine cavity, it became apparent that the views previously held concerning implantation were erroneous, and Peters concluded

PLATE IV.


Ref.
U.E.
Mes.
Tr.
a.
Cap
G.
Sy.
Bl.S.
Sy.
Fib.
D.C.
Sy.
b.
Sy.
U.
Re
Tr.
Cap.
Bl.S.
Emb.
G.
Mes.
G.
Tr.
D.C.
Cap.
Comp.

PETERS' OVUM. × 50.

Bl.S., blood spaces; *Cap.,* capillary; *Comp.,* compact layer of decidua; *D.C.,* decidual cells; *Emb.,* beginning embryo; *Fib.,* mass of fibrin covering point of entry of ovum into decidua; *Mes.,* connective-tissue layer of chorion; *Ref.,* decidua reflexa; *Syn.* syncytium; *Tr.,* trophoblast; *U. E.,* uterine epithelium.

that it could be explained only by some such mechanism as that described by Spee. Since that time a constantly increasing mass of evidence has accumulated in support of such a view, which is now universally accepted as correct.

Following the appearance of Peters' monograph, a number of very early ova in situ have been described, and scarcely a year elapses without one or two additional specimens being added to the list, with the result that they have become too numerous for ready enumeration. None of these ova exceed 5 millimeters in diameter, and vary in age from the latter part of the second to the end of the third week after fertilization. In each instance the ovum is imbedded in the superficial portion of the decidua and is separated from the uterine cavity by a definite, but thin, layer of tissue; and, when the entire uterus is available for study, appears as a minute vesicular structure whose upper pole projects somewhat beyond the general surface of the mucosa. In many instances, a funnel-shaped defect apparently marks the point of ingress of the ovum; which in a certain number of specimens is covered by a mushroom-shaped mass of fibers infiltrated with leukocytes, while in still other specimens the tissue in this locality presents so complicated a structure that Teacher has designated it as the *operculum.*

The youngest of these ova was described by Miller in 1913 and was probably ten or eleven days old; that of Grosser was a little older, and was closely followed by that of Bryce and Teacher which was probably thirteen days old; no data are available for calculating the ages of the ova of Linzenmeier and of Young, but they are clearly younger than that of Peters, which is estimated to be seventeen or eighteen days old. The remainder of the ova in the series are about the age of Peters' ovum, but none are older than the end of the third week after fertilization.

As previously intimated, no direct evidence is available as to what happens to the ovum between the time of fertilization and the stage represented by Miller's specimen, ten or eleven days later. If we admit with Grosser that a period of at least seven days elapses between fertilization and implantation, it may be assumed that this ovum represents the extent of development which occurs during the three or four days immediately following implantation, and that what is needed is information concerning the intermediate stages.

In order to supply this temporary deficiency, Mr. Broedel was kind enough to prepare Plates IV, *A* and *B,* in which Figure 1 represents the mature ovum pictured in Figure 79, while Figures 7-10 represent the ova of Miller, Linzenmeier, Bryce and Teacher, and Peters, respectively, each magnified 50 diameters. Figures 2 and 3 represent the ovum in the two-cell morula stage, and Figures 4 to 6 represent hypothetical ova in various stages of implantation preceding that observed by Miller. These latter figures are slightly modified from those prepared by Graf Spee, and may or may not correctly represent what actually occurs. In any event, the plate gives a graphic idea of the phenomenal changes which occur in the seventeen or eighteen days elapsing between fertilization and the stage of development represented by Peters' ovum, and shows beyond peradventure that the human ovum early makes its way into the depths of the decidua, and does not remain upon its surface as was formerly supposed.

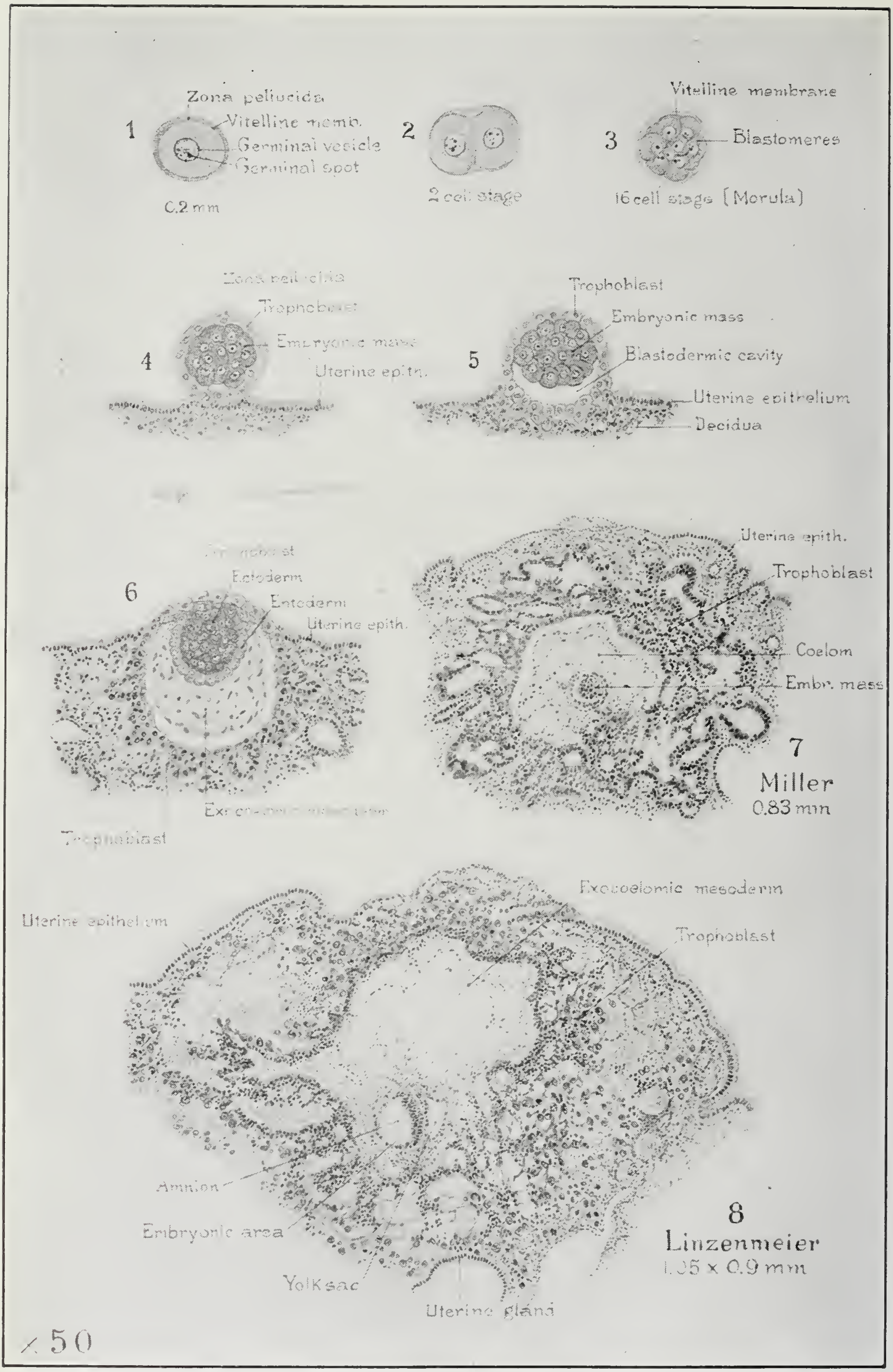
Formation of the Chorion and Amnion.—In each of the early ova depicted in Plate IV, *A* and *B*, it is seen that the center of the ovum consists of very loosely meshed mesodermic tissue—primitive mesoderm, containing at its basal portion a small mass of cells, as in Miller's specimen, or two minute cavities, as in Figures 8, 9 and 10, to which reference will soon be made. Outside of this comes a thick capsule of ectodermal tissue—the trophoblast, in which two types of cells can be distinguished. The first, immediately adjoining the mesodermic tissue, consists of a single layer of cells with sharply marked outlines; while the second, which also contains individual cells, is characterized by the presence of masses and bands of protoplasm containing nuclei, but not divided into individual cells. The trophoblastic capsule, which is the most characteristic feature of the ovum at this time, varies greatly in thickness in its several portions, is actively invading the surrounding maternal tissue and opening up its blood vessels and gland spaces.

In Peters' ovum the mesodermic tissue has in great part become consolidated into a thin layer immediately inside of the trophoblast, while from its periphery outgrowths extend into the latter and represent the earliest stage in the formation of chorionic villi. At this period the trophoblast with its mesodermic lining constitutes the chorion, while the cavity included within it is designated as the extra-embryonic cœlom or magma cavity.

In Miller's ovum the small collection of cells at the basal portion of the mesodermic core represents the embryonic mass, while in the ova of Linzenmeier and Peters two cavities surrounded by mesoderm are present, and represent the amnion and the yolk sac. In the lining of the former, two types of ectodermal cells may be distinguished—first, a single layer of flattened cells, which constitute the amniotic epithelium, and second, several layers of larger cells, which constitute the embryonic plate or shield, which, however, at this time shows no sign of further differentiation. The yolk sac is lined by a single layer of entodermal cells.

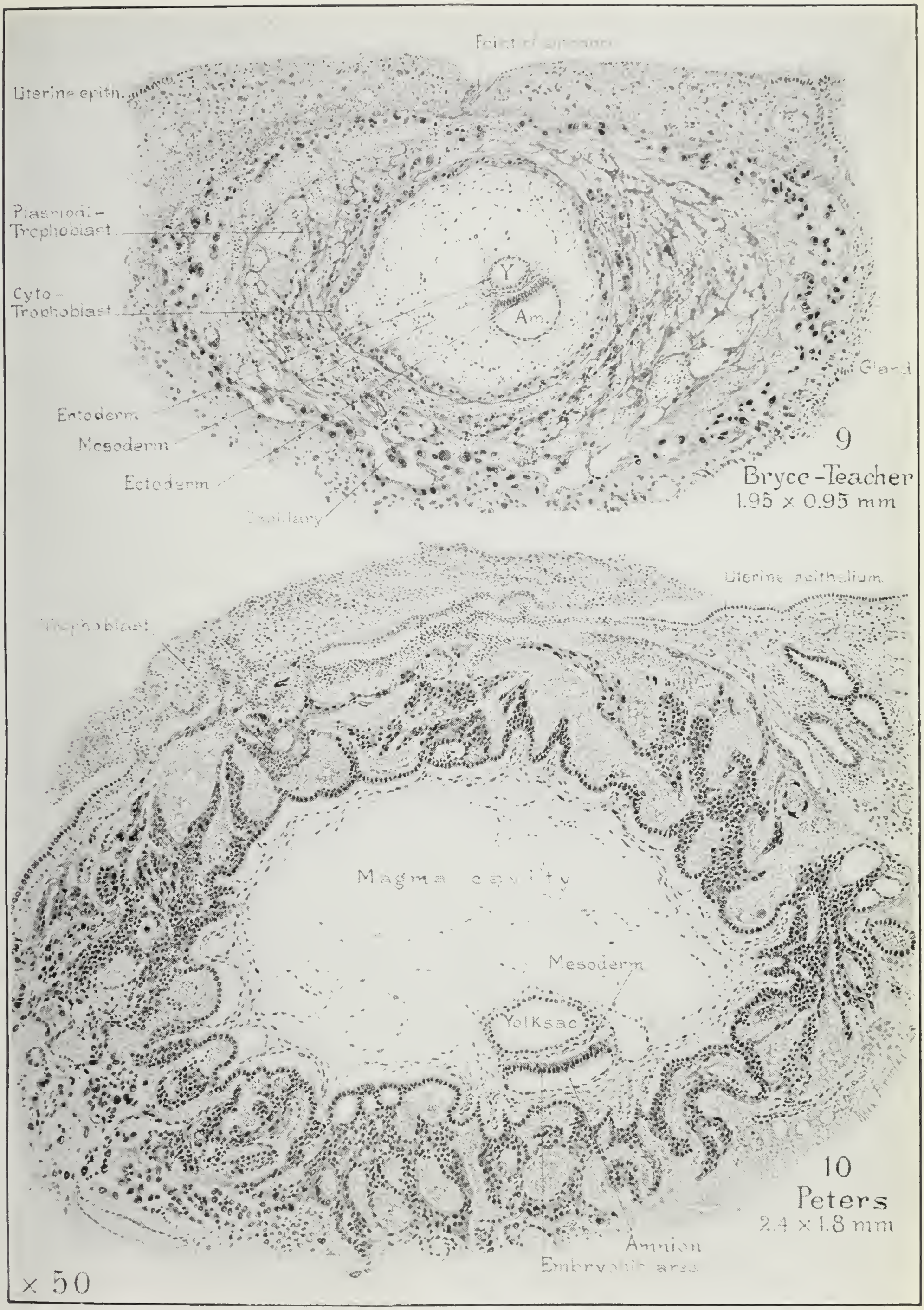
In other words, these early ova already present the three primary germ layers—ectoderm, mesoderm and entoderm, and consist of a relatively highly developed chorion with its mesodermic and trophoblastic layers inclosing a relatively large cœlomic cavity, and a small flattened amniotic cavity, one side of which is occupied by the embryonic shield, which as yet presents no sign of the future embryo. It is, therefore, apparent that in man the chorion and amnion do not develop in the same manner as in the chick, rabbit or dog, as in them there is no sign of the amnion until the embryo has taken on a distinct form, when it appears as folds of somatopleure which arch over the embryo and eventually meet and fuse. Furthermore, the mesodermic tissue has attained a degree of development far out of proportion to that observed in those animals.

Consequently, some other mechanism must be invoked to explain the forma-


1
Zona pellucida
Vitelline memb.
Germinal vesicle
Germinal spot
0.2 mm
2
2 cell stage
3
Vitelline membrane
Blastomeres
16 cell stage (Morula)
Zona pellucida
Trophoblast
Embryonic mass
Uterine epith.
4
5
Trophoblast
Embryonic mass
Blastodermic cavity
Uterine epithelium
Decidua
6
Trophoblast
Ectoderm
Entoderm
Uterine epith.
Exocoelomic mesoderm
Trophoblast
Uterine epith.
Trophoblast
Coelom
Embr. mass
7
Miller
0.83 mm
Exocoelomic mesoderm
Uterine epithelium
Trophoblast
Amnion
Embryonic area
Yolk sac
Uterine gland
8
Linzenmeier
1.05 x 0.9 mm
× 50

DIAGRAMS ILLUSTRATING CHANGES IN THE FERTILIZED OVUM DURING THE PROCESS OF IMBEDDING.

PLATE IV, *B*


Point of entrance
Uterine epith.
Plasmodi-Trophoblast
Cyto-Trophoblast
Y
Am.
Gland
Entoderm
Mesoderm
Ectoderm
Capillary
9
Bryce-Teacher
1.95 × 0.95 mm
Uterine epithelium
Trophoblast
Magma cavity
Mesoderm
Yolk sac
10
Peters
2.4 × 1.8 mm
Amnion
Embryonic area
× 50

DIAGRAMS SHOWING MATURE OVUM AND ITS CHANGES AFTER FERTILIZATION.

tion of the amnion and chorion in man. In certain mammals, particularly when abundant room is not available in the uterine cavity for the expansion of the fœtal membranes, the embryonic mass develops upon the interior, instead of upon the exterior, of the blastodermic vesicle, giving rise to the so-called inversion of the membranes—"entypie." This process has been studied particularly by Graf Spee and Duval in the guinea-pig, by Sobotta in the mouse, and by Huber in the white rat, but probably does not occur in man, for the reason that in the animals mentioned only a small portion of the periphery of the ovum consists of chorion, while its greater part is covered by entoderm homologous with that lining the yolk sac; whereas in man the chorion persists up to the time of birth as the outermost membrane of the product of conception, and the yolk sac is preserved as a closed vesicle until the termination of pregnancy.

All authorities agree in assuming that following fertilization the human ovum undergoes segmentation and eventually becomes converted into a blastodermic vesicle, but here the analogy with what occurs in the chick, rabbit, or dog ceases; and the evidence available indicates that in man the embryonic mass or area develops upon the interior of the blastodermic vesicle, rather than upon its exterior, as in the animals in question. At the same time, the process differs materially from the "entypie" as observed in many rodents. For these reasons, it appears conceivable that the changes which occur in the human ovum during the first few hours or days following implantation may resemble those which Van Beneden has demonstrated in the bat. In that animal the internal cell mass forms a lenticular enlargement upon the inner surface of the blastodermic vesicle. By the degeneration of the cells in its center and by the accumulation of fluid a cavity appears, which constitutes the amnion, while the embryonic area is developed from the cells at its base (Figs. 118, 119 and 120). Indeed, the only serious argument against such a supposition consists in relative paucity of mesoderm, which is so conspicuous a feature in the earliest human ova.

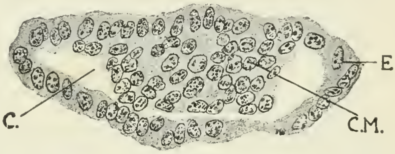


Fig. 118.—Blastodermic Vesicle of Bat (Van Beneden). × 275.
C., cavity of vesicle; *C.M.*, internal cell mass; *E.*, enveloping layer.

As the earliest stages of development have not been observed in monkeys, no clue can be derived from that source, but the early ova described by Selenka bear a striking similarity to human ova of the third and fourth weeks, and likewise indicate that in that species the amnion and embryo do not originate as in the chick or the rabbit. Thus, a section through an early ovum of the gibbon shows a well-developed chorion and cœlomic cavity, while the small embryo is suspended in the latter by a pedicle arising from the inner surface of the chorion.

As has already been stated, the earliest human ovum with which we are acquainted was briefly described by Miller, in 1913, and redescribed by Streeter in a beautifully illustrated monograph (1927). This ovum was accidentally discovered in material removed from the uterus by curettage for hemorrhage twenty days after the last menstrual period, and was estimated to be ten or eleven days old. It measured 0.83 millimeter in its greatest diameter and consisted of a mesodermic core 0.44 millimeter in diameter, surrounded by a thick trophoblastic capsule, which was actively invading the surrounding maternal tissue. Slightly basal to its center was a mass of ectodermal cells, measuring 0.095 by 0.072 millimeter, with a small central cavity, which Miller identified as the amnion and embryonic shield; while Streeter considers a small group of cells to one side of it as a very rudimentary yolk sac. Streeter's study and illustrations show that the ovum is normal and it is doubtless the youngest yet observed.

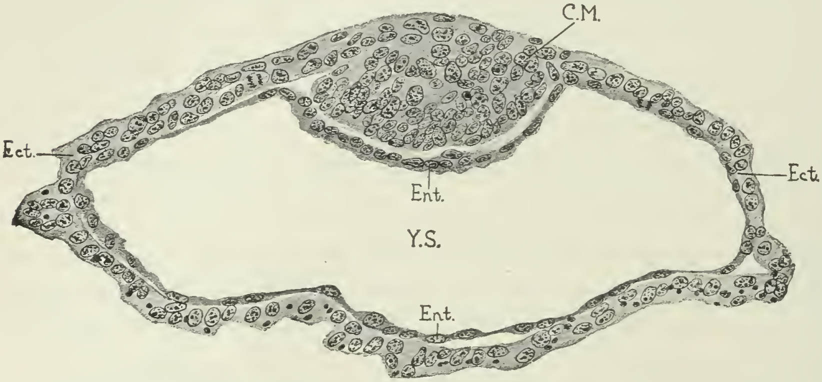


Fig. 119.—Blastodermic Vesicle of Bat (Van Beneden). × 200.
C.M., cell mass; *Ect.*, ectoderm; *Ent.*, entoderm; *Y.S.*, yolk sac.

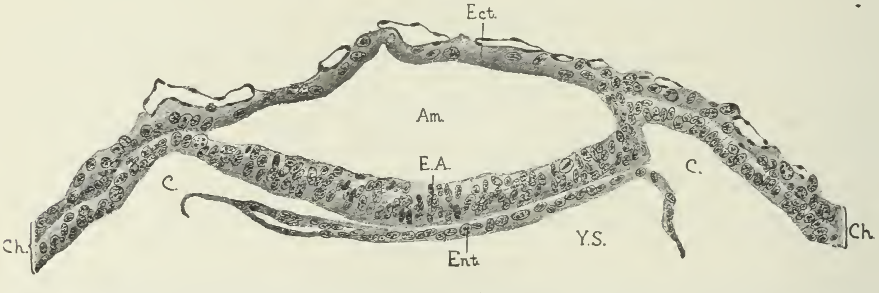


Fig. 120.—Bat Ovum (Van Beneden). × 200. Showing Amnion and Embryonic Area.
Am., amnion; *C.*, cœlom; *Ch.*, chorion; *E.A.*, embryonic area; *Ect.*, ectoderm; *Ent.*, entoderm; *Y.S.*, yolk sac.

The ovum described by Grosser (Kleinhans) represents the next youngest human ovum, but it is a matter of doubt whether the one described by Linzenmeier or that described by Bryce and Teacher should be assigned to the third place in the series. The former is definitely smaller than the latter, but at the same time presents a slightly more advanced stage of development. It was very well preserved and occupies a place midway between the specimens of Miller and Peters. There is some doubt as to whether the ovum of Bryce and Teacher is entirely normal, and for that reason it will be described last.

Linzenmeier's ovum was found in a uterus removed on account of hemorrhage from a woman who had been curetted one month previously. It was imbedded in the decidua and measured 1.04 × 0.9 millimeter (Plate IV, *A*, Fig. 8). It consisted of a chorionic membrane with actively proliferating trophoblast and a few rudimentary villi. The cœlomic cavity was traversed by numerous mesodermic strands, and at its basal portion, broadly attached to the connective tissue of the chorion, were two cavities surrounded by mesoderm; a larger one corresponding to the amnion and a smaller one to the yolk sac. On one side of the amniotic cavity was an embryonic shield made up of several layers of ectoderm and measuring 0.21 × 0.15 millimeter, but showing no sign of a primitive groove. (Fig. 121.)

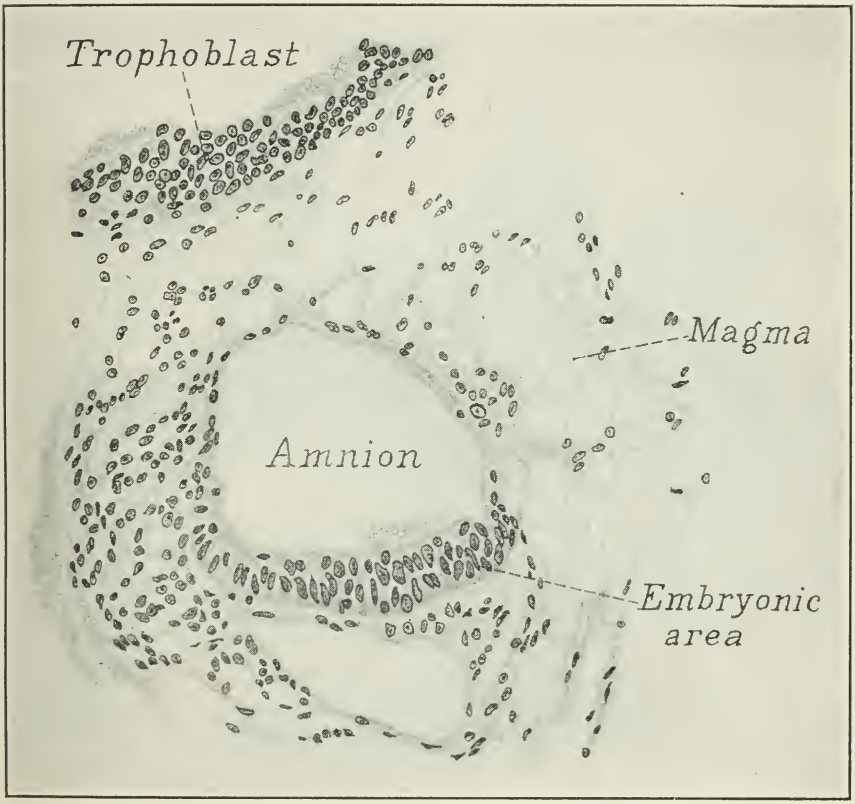


Fig. 121.—Embryo from Linzenmeier's Ovum attached to Chorionic Membrane, Highly Magnified.

Bryce and Teacher's ovum was described in 1908; was found in a shred of decidual tissue expelled eleven days after a menstrual period should have begun; measured 1.95 × 0.95 millimeter, and was estimated to be thirteen or fourteen days old (Fig. 117 and Plate IV, *B,* Fig. 9). It consisted of a vesicle filled with mesodermic tissue, which contained two small cavities, each lined by a single layer of cuboidal cells, which were interpreted as the amnion and yolk sac, respectively. The outer wall of the vesicle was composed of several layers of ectodermal cells, presenting all stages of cell division, while springing from its periphery were irregularly shaped, branching and interlacing masses of vacuolated protoplasm, not divided into individual cells, and which extended to the margins of the implantation cavity, opening up maternal vessels, whose contents had escaped into the meshes of the protoplasmic network. The trophoblastic capsule was unusually extensive, and in view of its extraordinarily open structure is not considered normal by many authorities.

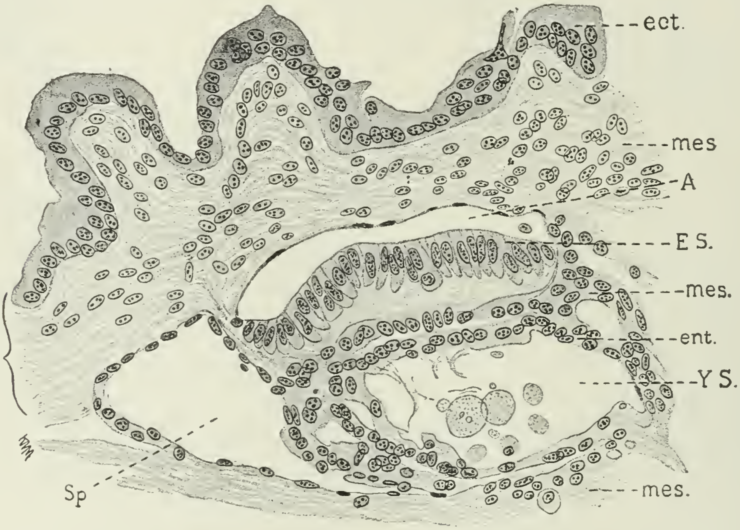


Fig. 122.—Portion of Peters' Ovum, Highly Magnified, Showing Early Stage in Development of Embryo.

A, amnion; *C,* chorion; *etc.,* ectoderm; *ent.,* entoderm; *mes.,* mesoderm; *E.S.,* embryonic shield; *Y.S.,* yolk sac; *Sp.,* portion of cœlom.

The next earliest ovum was described by Peters in 1899, and is of especial interest for the reason that its description afforded the basis for our present ideas concerning the mode of implantation of the ovum and the development of the chorion and amnion in man. It was found in the uterus of a woman who committed suicide three days after missing her menstrual period, and was originally considered to be only three or four days old, although it is now generally recognized as being two weeks older. It measured 1.6 × 0.8 × 0.9 millimeter in its various diameters, and presented a well-developed chorion with rudimentary villi inclosing a large cœlomic cavity, a very small amnion, an embryonic area and a yolk sac. Plate IV represents a section through the portion of decidua in which it was imbedded, and shows that the chorion is made up of two layers—a thin inner layer of connective tissue, to whose basal portion the amnion and embryonic area are broadly attached, and which forms the lining of the cœlomic cavity, and an outer layer composed of many layers of ectodermal cells. In Peters' opinion, this trophoblastic capsule represented the primitive ectoderm of the ovum. The majority of its cells possess well-marked, rounded or cuboidal bodies with vesicular nuclei. Scattered between them, especially when in contact with maternal blood, are masses of protoplasm which show no sign of division into individual cells, and contain irregularly shaped, darkly staining nuclei—syncytium. The trophoblast has deeply invaded the surrounding decidual tissue and has opened up numerous blood vessels, so that many large, irregularly shaped spaces have developed, which contain maternal blood and represent the forerunners of the intervillous spaces of the fully formed placenta. From the connective-tissue layer of the chorion, which is not yet vascularized, numerous small processes extend into the trophoblast and represent the earliest stages in the formation of chorionic villi. Figure 122 is a highly magnified section through the amnion and embryonic area, and shows that the former is a mere flattened slit, and that the latter is made up of several layers of large ectodermal cells, which as yet show no signs of a primitive streak.

In all early ova, which are approximately of the same age as Peters' specimen, the amnion and embryonic area are broadly attached to the basal portion of the inner surface of the chorionic membrane, or, in other words, as far away from the uterine cavity as possible, with the apparent purpose of having the embryo placed at a point where the future maternal blood supply will be assured. This, however, is a transient condition; for, as the embryo becomes larger, its area of attachment becomes relatively narrower, becoming converted into a sort of peduncle—the abdominal pedicle or body stalk, the forerunner of the umbilical cord, by which the embryo hangs from the chorionic membrane into the cœlomic cavity (Figs. 125 and 127).

Moreover, while none of the early ova are entirely spherical, they tend to become lenticular in outline with increasing age, so that by the end of the fourth week the longitudinal diameter greatly exceeds the vertical, as is seen by comparing Figures 123 and 124. Likewise, there is a marked change in the relative size of the yolk sac. In very early ova it is smaller than the amnion and embryonic area, but within a short time the relations become reversed, so that it becomes so large that the amnion and embryonic shield sit upon it as a mere protuberance (Figs. 125 and 126). This, however, is a transient phenomenon, as the increase in size soon ceases, while the embryo continues to grow, so that at the end of pregnancy the yolk sac constitutes only a minute fraction of the entire product of conception. It is, however, important to remember that, aside from the chorion, the yolk sac is the most imposing constituent of the early ovum during the third and fourth weeks of development, which must indicate that at that time it fulfills some important function.

In the early ova thus far considered, the embryonic shield is merely a smooth

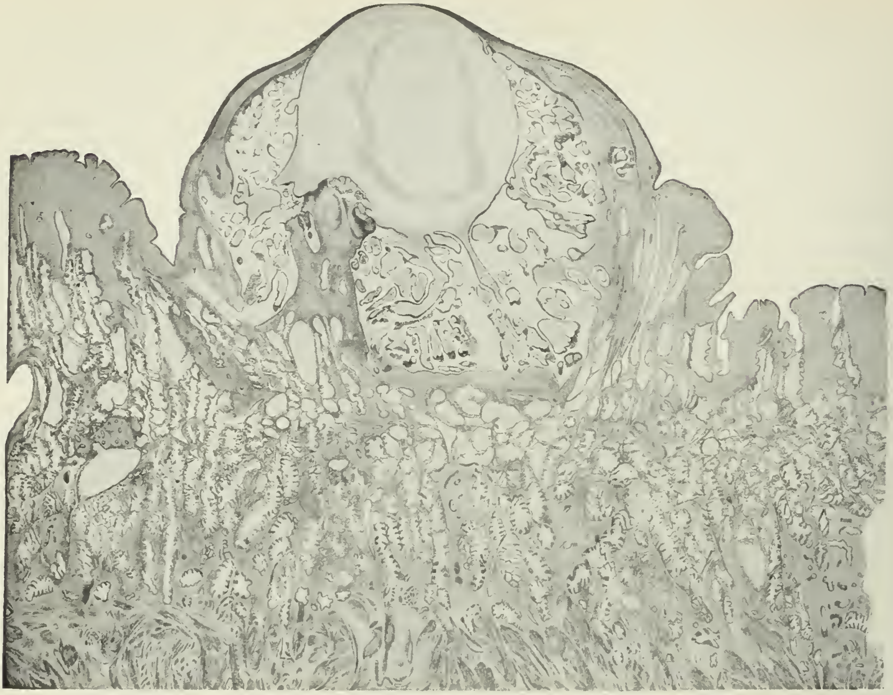


FIG. 123.—MICROSCOPIC SECTION, SHOWING OVUM EMBEDDED IN DECIDUA AND SURROUNDED BY DECIDUA CAPSULARIS, PROBABLY SEVENTEEN DAYS OLD (Leopold).

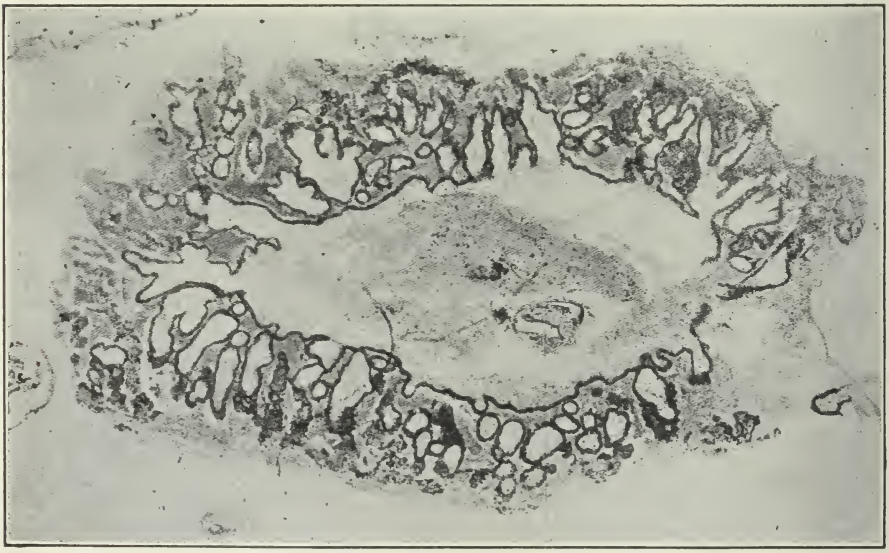


FIG. 124.—SECTION THROUGH EARLY HUMAN OVUM, SHOWING CHORIONIC VESICLE, CONTAINING IN ITS INTERIOR THE CŒLOMIC CAVITY AND THE MINUTE EMBRYO, CONSISTING OF TWO CAVITIES UNITED BY MESODERM, THE LARGER BEING THE YOLK SAC AND THE SMALLER THE AMNIOTIC CAVITY WITH THE EMBRYONIC AREA (Streeter). × 25.

plate of ectodermal cells, whose margins are continuous with the flattened cells which line the interior of the amnion. The first change indicative of the formation of the embryo is the appearance of the primitive groove toward the latter part of the third week. This is well exemplified in Figures 125 and 126, Streeter's ovum. This measured 9 × 8 × 3.5 millimeters and was obtained at operation eleven days after the failure of menstruation to appear. Figure 125 represents a portion of the chorionic membrane, to which the embryo, consisting of the flattened amniotic cavity, the embryonic shield, and the relatively large yolk sac, is attached by the abdominal pedicle, which contains in its interior a tubule lined by entoderm, which represents all of the allantois that is formed in man. Figure 126 represents a surface view of the same ovum, showing the large yolk sac, with the embryonic plate resting upon it and outlined by the cut edges of the amnion. The primitive groove extends forward from the cut end of the abdominal pedicle or body stalk. These specimens once more emphasize the fact that in man the amnion cannot originate from folds of the somatopleure as in the chick.

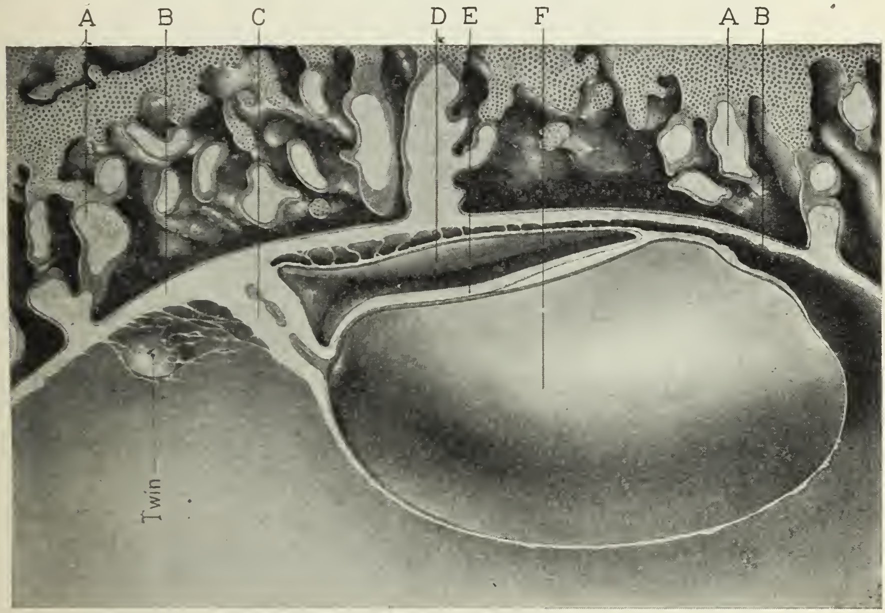


Fig. 125.—Median View of Wax Reconstruction of Mature Ovum, Showing the Amniotic Cavity and Its Relations to Chorionic Membrane and Yolk Sac (Streeter). × 50. *A.*, chorionic villi; *B.*, chorionic membrane; *C.*, body stalk with allantois; *D.*, flattened amniotic cavity; *E.*, embryonic area; *F.*, yolk sac.

Another ovum from the third week, described by Graf Spee, serves to confirm the views just stated concerning the formation of the amnion. This ovum measured 6 × 4.5 millimeters, and possessed a chorion with well-developed villi, a portion of which is shown in Figure 127. Projecting from its interior by the abdominal pedicle is a small vesicular structure—the beginning embryo.

Figure 128 represents a cross section through it, and shows clearly the relations of its various parts. The embryo is attached to the inner surface of the chorionic membrane by the *abdominal pedicle,* and its greater portion is occupied by the yolk sac, from one end of which a small process, lined by entoderm, which must be considered as a rudimentary allantois, extends into the pedicle. Occupying one side of the pedicle is a small cavity lined by a single layer of epithelium, which represents the amnion. On one side of this, again, is a mass of cells arranged in several layers—the embryonic area, in which a primitive streak can be distinguished. Figure 129 represents a highly magnified section through the same ovum, and shows that the three germ layers are well developed, each of which, with the exception of the entoderm, consists of several layers of cells.

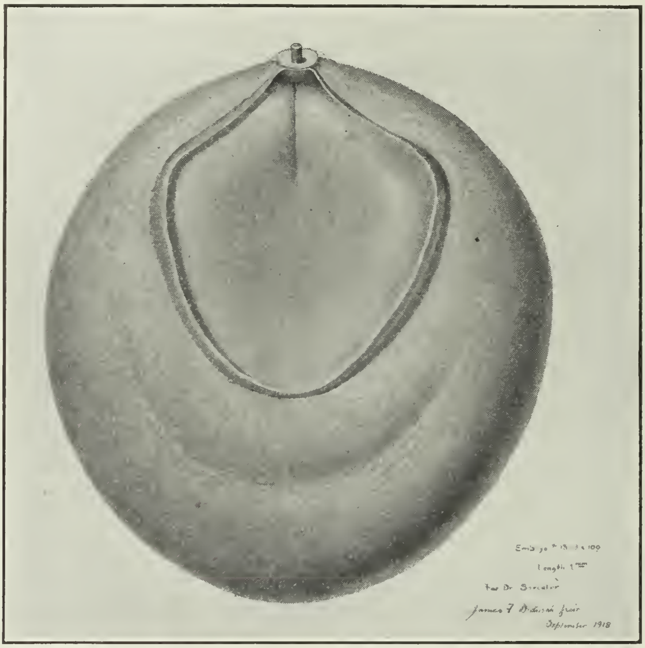


FIG. 126.—FRONTAL VIEW OF OVUM SHOWN IN FIG. 125, SHIELD-SHAPED EMBRYONIC AREA, WITH PRIMITIVE GROOVE, RESTING UPON THE RELATIVELY LARGE YOLK SAC.

The bandlike structure bounding the embryonic area represents the basis of the amnion, whose major portion has been cut away. The structure at the more pointed extremity of the amnion represents the severed body stalk, with the allantois in its center (Streeter). × 50.

Figures 130 and 131 represent an older ovum with an embryonic area 2 millimeters long, which was also described by Graf Spee. The embryo is attached to the inner surface of the chorion by the abdominal pedicle, and is still made up in great part of the yolk sac. The embryonic area is oval in shape, and presents a definite medullary groove and primitive streak. The two are not in the same plane, but the latter is bent almost at right angles to the former and occupies the inferior end of the embryonic area. Between the two is a small opening, the neurenteric canal, which serves to connect the ectoderm with the entoderm. Figure 131 represents a section through the same ovum, and shows a well-developed chorion with typical villi, while the amnion is a small sac closely applied over the beginning embryo. A highly magnified cross section (Fig. 132) shows the three germ layers and a well-developed somatopleure and splanchnopleure. By the folding in of the former it is readily understood how the body walls are formed, and by that of the latter how the primitive gut becomes differentiated from the yolk sac.

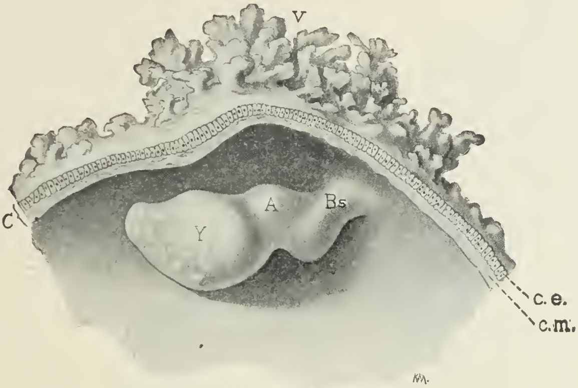


Fig. 127.—Spee's Human Ovum (Embryonic Area. 0.4 Millimeter Long). × 24. *A.*, amnion; *Bs.*, abdominal pedicle; *C.*, chorion; *c.e.*, chorionic epithelium; *c.m.*, chorionic mesoderm; *V.*, chorionic villi; *Y.*, yolk sac.

In studying early human ova, two fundamental facts should be borne in mind. In the first place, several phases should be distinguished in the growth of the trophoblast, which appears to present two stages of proliferation: A first and temporary one, which is primarily concerned in the fixation or implantation of the ovum; and a second or more permanent one, which has to do with the ectodermal covering of the chorionic villi. Accordingly, Teacher, Streeter, and Grosser distinguish between implantation and placental cytotrophoblast. Indeed, the latter goes so far as to enumerate five stages in its differentiation. In the second place, the so-called primitive mesoblast, which at first fills, and later lines, the cœlomic cavity, differs essentially from the mesoblast occurring in other

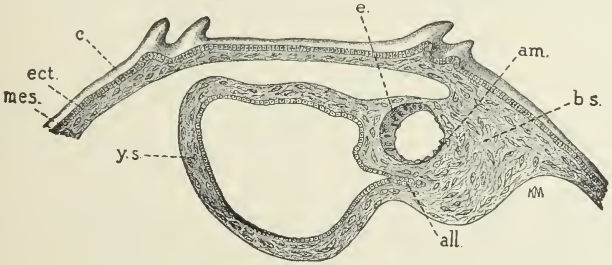


Fig. 128.—Section through Spee's Ovum, Shown in Preceding Figure. × 24. *c.*, chorionic membrane; *ect.*, ectoderm; *mes.*, mesoderm; *am.*, amnion; *e.*, beginning embryo; *bs.*, abdominal pedicle; *all.*, allantois; *y.s.*, yolk sac.

animals, as well as from that taking part in the formation of the human embryo itself. As has already been indicated, the latter arises from the under surface of the embryonic shield in close proximity to the primitive streak, while the former is well developed before the embryonic shield becomes distinguishable. For these reasons, Streeter sharply distinguishes between the body and primitive mesoderm, and is inclined to believe that the latter is derived from the trophoblast.

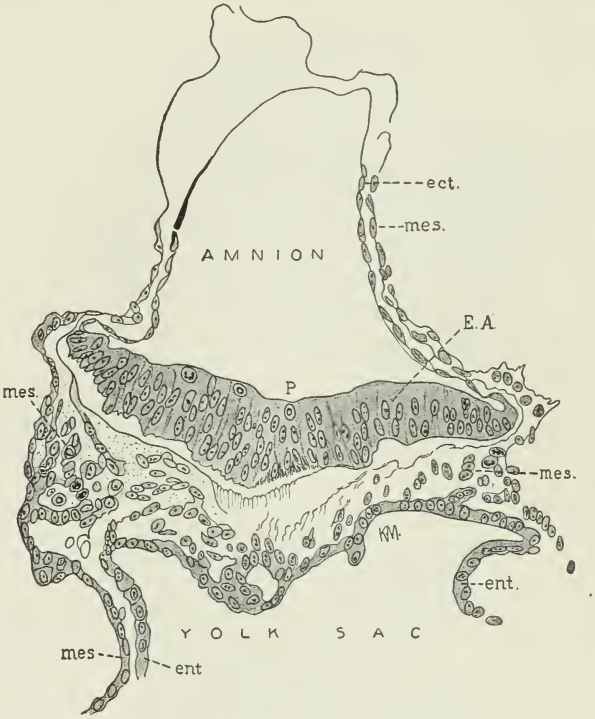


Fig. 129.—Cross Section through Spee's Ovum. Highly Magnified. *E.A.*, embryonic area; *P.*, primitive streak; *ect.*, ectoderm; *ent.*, entoderm; *mes.*, mesoderm.

Development and Anatomy of the Placenta.—The placenta may be defined as the organ by which intimate union is effected between the mucosa of the maternal generative tract and the embryonic adnexæ, particularly the chorion, for the purpose of facilitating the transfer of the nutritive material from the mother to the fœtus, and of excrementitious material in the reverse direction.

In the various species of animals the placenta exhibits such pronounced differences in the mode of union between fœtal and maternal tissues, in intimate structure, as well as in gross appearance, that it is safe to say that no other organ in the animal economy, which serves a single function, presents such marked variations. For example, the liver or kidney is practically identical in all mammalia, yet the placenta of swine differs so radically from that of the guinea-pig that the casual observer would hesitate to conclude that he had to deal with the same organ, were it not obvious that it serves a similar function in each animal. For this reason, it is unsafe to apply to a given animal conclusions which have been drawn from the study of the placenta of any other species, even though closely related. Consequently, in considering the human placenta, it is essential that our conclusions be based entirely upon the study of placentation in human beings. Before taking up a detailed study of the placenta, it would seem advisable to consider separately certain points concerning the anatomy of the three parts which enter into its composition—namely, the chorion, amnion and decidua.

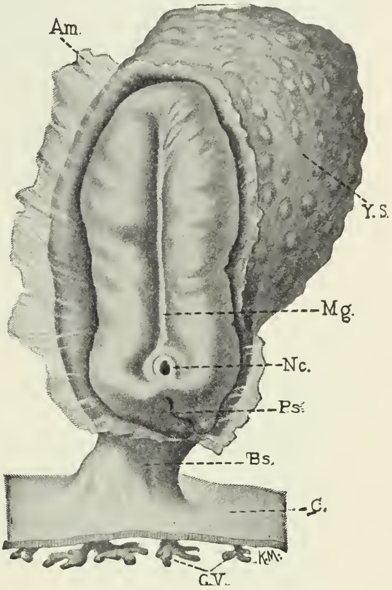


Fig. 130.—Human Embryo 2 Millimeters Long (Graf Spee). × 30.
Am., amnion; *C.*, chorion; *C.V.*, chorionic villi; *Bs.*, Bauchstiel; *Mg.*, medullary groove; *Nc.*, neurenteric canal; *P.s.*, primitive streak; *Y.S.*, yolk sac.

A. Structure of the Chorion.—In its very earliest stages the chorion probably consists of the single layer of ectodermal cells forming the wall of the blastodermic vesicle (Figs. 4, 5 and 6, Plate IV, *A*). Soon after the implantation of the ovum, however, as shown by the researches of Hubrecht, Huekelom, Peters and all subsequent investigators, the chorionic epithelium rapidly proliferates and invades the surrounding decidual tissue, forming the many-layered trophoblast; which is lined internally by the primitive mesoderm. In a short time buds from the latter make their way into the trophoblast and give rise to rudimentary villi (Plate IV).

Within a short time the entire periphery of the chorion becomes covered by villi, which rapidly increase in size and complexity and give it a shaggy appearance—chorion frondosum (Figs. 133 and 134). In an ovum from the latter part of the third week Stieve was able to count 942 individual villi.

Figure 135 represents a section through a portion of the periphery of a four weeks' pregnancy and shows the relations between the chorion and the underlying decidua. Above is the chorionic membrane with rudimentary villi projecting from it. The membrane consists of two layers—the inner of connective tissue, the outer of epithelium. The former is composed of spindle- and star-shaped cells embedded in a mucoid intercellular substance, and at this period does not contain blood vessels. The latter is arranged in two layers; an inner, adjoining the connective tissue, which is composed of cuboidal or roundish cells with clear protoplasm and lightly staining vesicular nuclei—Langhans' layer, and an outer layer made up of coarsely granular protoplasm, which shows no signs of division into cells, and through which are scattered irregularly shaped, darkly staining nuclei—the syncytium.

Each villus arises from the chorionic membrane as a single stem, which later gives origin to numerous branches which assume an arborescent form, the complexity of which increases with advancing age. The villi consist of a connective-tissue stroma and an epithelial covering, each of which is continuous with the corresponding tissue of the chorionic membrane. At this time they do not contain blood vessels. It will be noted that most of the villi extend directly

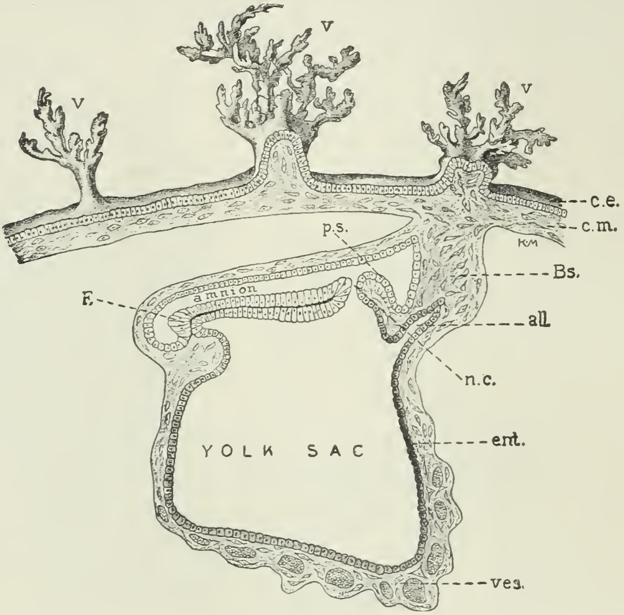


Fig. 131.—Section through Human Ovum Shown in Fig. 130 (Spee).
all., allantois; *c.e.*, chorionic epithelium; *c.m.*, chorionic mesoderm; *Bs.*, abdominal pedicle; *E.*, beginning embryo; *ent.*, entoderm; *n.c.*, neurenteric canal; *p.s.*, primitive streak; *V.*, chorionic villi; *ves.*, vessels in wall of yolk sac.

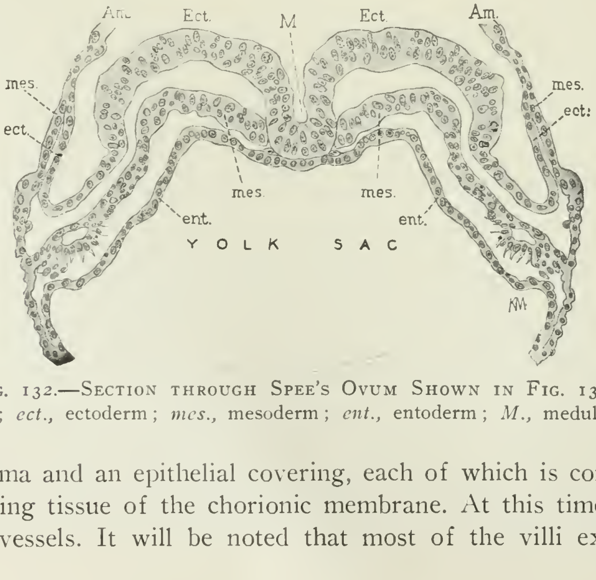


Fig. 132.—Section through Spee's Ovum Shown in Fig. 130.
Am., amnion; *ect.*, ectoderm; *mes.*, mesoderm; *ent.*, entoderm; *M.*, medullary groove.

from the chorionic membrane to the decidua, to which they are attached by proliferating trophoblast. At the tips of the villi the cells are generally of the Langhans' type, while in other places buds and masses of syncytium are seen invading the decidua and opening up its vessels. A few villi do not reach the decidua, but project into spaces lying between the chorionic membrane and decidua—the so-called placental or intervillous space. Projecting here and there from the surface of the villi are epithelial buds, consisting of syncytium, and which, when seen in cross or tangential section, resemble giant cells. These buds

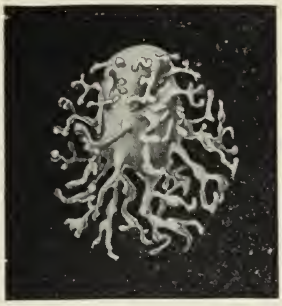


Fig. 133.—Early Human Ovum (Leopold).

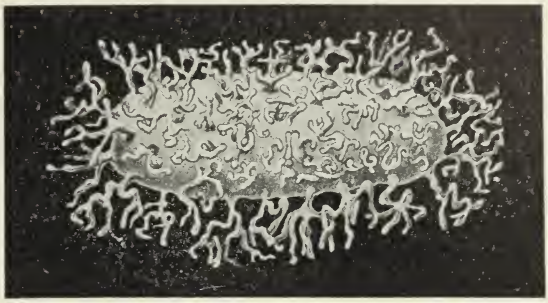


Fig. 134.—Three Weeks' Human Ovum (Leopold).

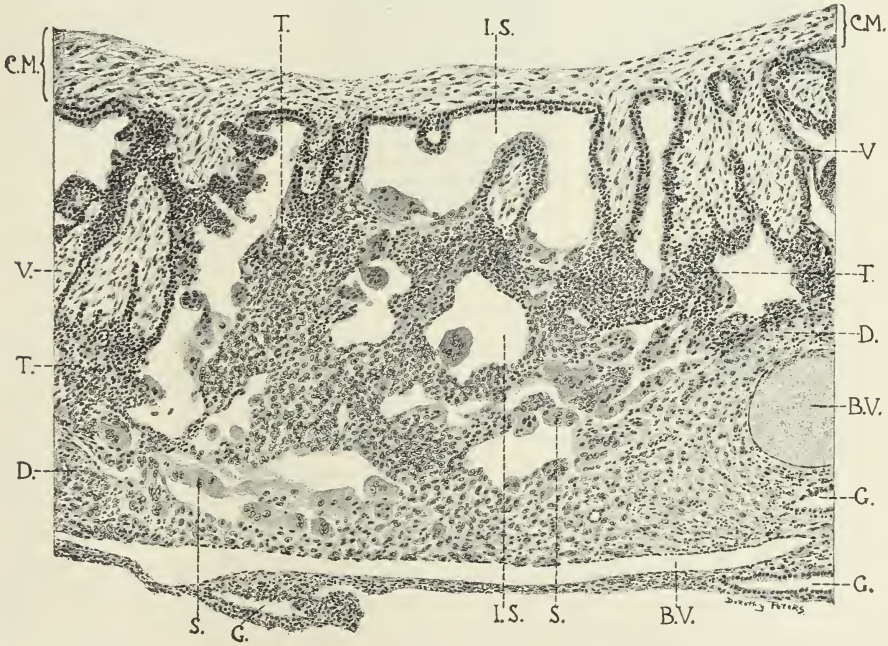


Fig. 135.—Section through Three Weeks' Human Ovum, Showing Chorion, Decidua, and Intervillous Spaces.

B.V., maternal blood vessel; *C.M.*, chorionic membrane; *D.*, decidua; *G.*, uterine gland; *I.S.*, intervillous space; *S.*, syncytium; *T.*, trophoblast; *V.*, villus.

indicate proliferation of the outer layer of the chorionic epithelium, and may represent the first stage in the development of new villous branches.

In early ova, the embryo is connected with the connective-tissue layer of the chorion by a mesodermic structure, which was first described by His as the *abdominal pedicle* or body stalk, and is the forerunner of the umbilical cord. Through this the umbilical vessels of the embryo eventually make their way to the chorionic membrane and there fuse with blood vessels which have originated in situ. In this way, the fœtal circulation gains access to the villi, and makes possible the exchange of substances between the maternal and fœtal blood.

In early pregnancy the villi are pretty equally distributed over the periphery of the chorionic membrane—chorion frondosum, but soon the greater part of them, which are in contact with the decidua capsularis cease to grow, and eventually undergo almost complete degeneration; while those in contact with the decidua basalis proliferate and form the fœtal portion of the placenta.

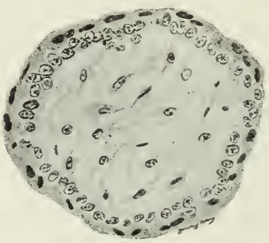


Fig. 136.—Chorionic Villus, Third Week. × 225.

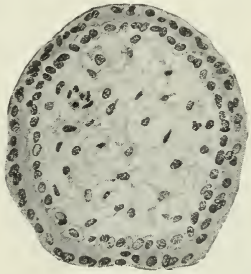


Fig. 137.—Chorionic Villus at Fourth Month. × 225.

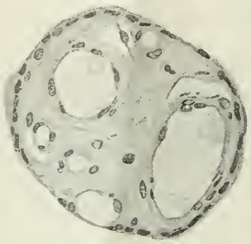


Fig. 138.—Chorionic Villus at Term. × 225.

After the greater part of the surface of the chorion has become denuded of villi, it is designated as the chorion læve or bald chorion.

A certain proportion of the villi forming the placenta extend from the chorionic membrane to the underlying decidua, attaching the ovum to it, and hence are designated as *fastening villi.* The majority, on the other hand, are arborescent structures, whose free endings do not reach the decidua. In early pregnancy the villi are short and plump and represent simply the main stems, but later they give off numerous branches and assume an arborescent appearance. Thus, sections through a young chorion show only a few large villi, while those through an older one are filled with a multitude of smaller branches. This change in appearance may be compared to what takes place in a clump of trees, which at an early period consists of a number of almost isolated trunks, each of which later gives off innumerable branches and twigs. These differences have been particularly emphasized by de Loos, who has shown that with a little practice one can roughly estimate the age of the chorion by its appearance on section.

The stroma of the villi also varies in appearance according to the age of the chorion. In the earlier stages the cells are branching in shape, and are separated from one another by a large amount of mucoid intercellular substance; later on they become more spindle-shaped and more closely packed together, so that the stroma assumes a denser appearance (Figs. 136 to 138). Another type of cell also occurs in the stroma—the so-called plasma or Hofbauer cell. These are roundish cells with vesicular nuclei and very granular or vacuolated protoplasm. In fresh specimens Warren H. Lewis has shown that their granules stain so characteristically with vital stains that he is inclined to classify them as clasmatocytes or histiocytes. They are present in all stages of pregnancy, but are most abundant during the early months. Hofbauer showed in this clinic that they are particularly abundant when the fœtus is defective or in the presence of infectious processes.

After the third week, but before there is any sign of the fœtal heart, blood islands appear in the mesodermic tissue of the chorion, and vascular walls soon appear around them. These coalesce to form larger vessels, and soon lead to complete vascularization of the chorion and its villi. Indeed, this is a favorite location for the study of the spontaneous development of blood cells and blood vessels, and the isolated blood islands with their nucleated red cells and delicate endothelial walls present a striking picture. It is important to remember that in man the chorionic vessels originate in situ, and are not derived from the allantois, as is often taught. The villous vessels soon become very abundant, and in the later months of pregnancy almost displace the stroma. The arteries and veins extend to the tips of the villi, where they break up into capillaries, but there is no anastomosis between the vascular supply of the various villi, any more than between the branches of different trees in a forest.

The *epithelium* covering the villi was mentioned by Dalrymple, in 1842, but was first definitely described by Langhans many years later. The latter pointed out that it was made up of the two layers already described (Fig. 136). The inner he designated as the *cell layer* (Zellschicht), although it is now generally known by his name; while the outer layer is described as the *syncytium*. This latter term was introduced in 1893 by Kossmann and Merttens, although the characteristics of the tissue had been recognized years before by Kastschenko, who designated it as *plasmodium*.

During the first half of pregnancy the two layers are readily distinguished, but later Langhans' layer becomes more and more indistinct, so that during the second half the villi are covered only by a single layer of syncytium. Figures 136 to 138 give a good idea of the successive changes in the stroma and epithelium at different ages. Careful examination of properly prepared specimens shows that the syncytial layer presents a vacuolated structure, and that its outer margin does not present a smooth surface, but is made up of a vertically arranged pseudopodialike protoplasmic process. These structures are too coarse to be considered as cilia, and are designated by Marchand, Bonnet, Hofbauer, and others as bristlelike processes.

The origin of the two layers of chorionic epithelium has given rise to a great deal of discussion, but it is now universally admitted that they are both ectodermal in origin, and are derived from the original trophoblast of the ovum. As a matter of history, it may be stated that Kossmann, in 1893, advanced the theory that the syncytium was derived from the epithelium of the uterus, while only Langhans' layer represented the original ectoderm, which was apparently confirmed by Merttens. This work was very plausibly set forth and accompanied by numerous excellent illustrations, so that the conclusions of Kossmann and Merttens were soon adopted by many authorities, but have since been abandoned. Furthermore, this theory is only one of a large number which have been advanced in explanation of the origin of the chorionic epithelium. Those who are interested in the subject are referred to the article of Waldeyer who, in 1890, was able to arrange in ten groups the numerous theories which had been advanced up to that time. In 1916, de Kervily studied mitochondrial formation in the chorionic villi, and his article represents a storehouse of information concerning all points connected with the minute anatomy of the chorion. It might also be mentioned that Neuwieler and others have made tissue-culture experiments with the early chorion and have succeeded in cultivating the connective tissue and Langhans' cells but not the syncytium.

B. Structure of the Amnion.—In the very earliest stages of pregnancy, as we have already shown (Fig. 112), the amnion is a minute vesicle; later it forms a small sac which covers only the dorsal surface of the embryo, and eventually becomes larger and completely surrounds it. At first the amnion occupies only a minute portion of the entire ovum; but as pregnancy advances it increases in size, until eventually it comes in contact with the interior of the chorion and obliterates the extra-embryonic portion of the cœlom. When the outer surface of the amnion has supplied itself to the inner surface of the chorion, the two membranes become slightly adherent, but are never very intimately connected, for even at the end of pregnancy they can be readily separated from one another.

From its earliest stages the amnion consists of two layers: an outer layer of mesoderm and an inner layer, made up of cuboidal or flattened, ectodermal cells. The mesodermic layer eventually becomes converted into mucoidlike tissue, which does not contain blood vessels; while the ectodermal portion is represented by a single layer of epithelial cells, which vary considerably in shape but tend to be cuboidal. They show definite signs of secretory activity, but I have not been able to confirm Schmidt's statement that some of them are of the beaker or mucous-cell variety. As the amniotic epithelium is homologous in origin with the cells making up the embryonic shield, they may be regarded as simply an extension of the skin of the embryo. This relationship is accentuated by the fact that in somewhat more than one-half of all placentæ, at term, small, rounded placques may be observed upon the amnion, particularly in the neighborhood of the attachment of the umbilical cord. Upon microscopical examination they are found to be made up of stratified epithelium, which bears a close resemblance to that of the skin. They are designated as *amniotic caruncles,* and will be considered more fully in the chapter on the pathology of the ovum.

Soon after its formation, a certain amount of clear fluid collects within the amniotic cavity—the amniotic fluid—which increases in quantity as pregnancy advances. The amount varies within wide limits, and according to Fehling averages about 600 cubic centimeters at the end of pregnancy, although under abnormal conditions it may vary from a few cubic centimeters to many liters. Its specific gravity ranges from 1.002 to 1.028, and it contains a certain amount of albumin, urea, creatinine, and various salts. Its origin and function will be considered when we take up the physiology of the fœtus.

C. Decidua.—The decidua is the mucous membrane of the uterus which has undergone certain changes under the influence of the ovulation cycle, to fit it for the implantation and nutrition of the ovum. It is so named from the fact that it is cast off after labor.

The conversion of the uterine mucosa into decidua occurs shortly after the fertilization of the ovum, though we are unable to state exactly when the process commences, inasmuch as the premenstrual swelling is accompanied by changes in structure, which must be regarded as pregravid or predecidual in character.

After conception the hypertrophic premenstrual endometrium grows still thicker and eventually attains a thickness of from 5 to 10 millimeters, while its surface becomes indented by furrows of considerable depth, which give the entire membrane a mamelonated appearance. Under the magnifying-glass numerous small openings can be distinguished which are the mouths of the uterine glands. The decidual formation is limited to the body of the uterus, and does not extend below the internal os, though in rare instances von Franqué, von Weiss, Volk, Lynch, myself and others have found isolated decidual cells beneath the cervical epithelium.

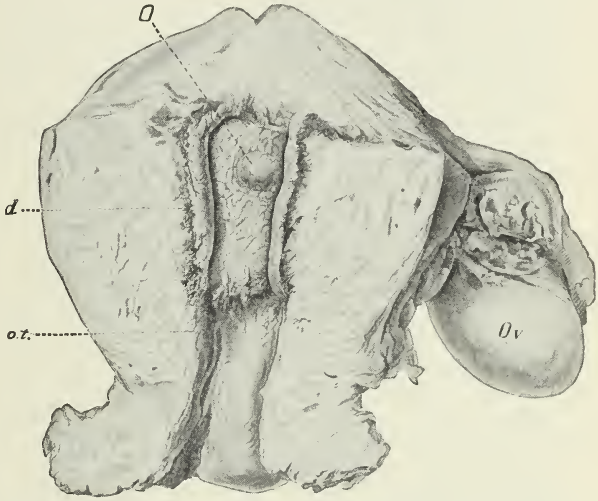


Fig. 139.—Uterus Lined by Decidua, Containing an Early Ovum (Leopold). × 1.
O, ovum; *d,* decidua; *o.t.,* internal os.

For purposes of description the decidua is divided into three portions: that lining the main cavity of the uterus being designated as the *decidua vera;* that beneath the ovum as the *decidua basalis* or *serotina;* while the portion which surrounds the ovum and shuts it off from the rest of the uterine cavity is known as the *decidua capsularis* or *reflexa.*

The terms *reflexa* and *serotina* date from the time of William Hunter, who gave excellent drawings of the decidual membrane in his atlas. Unfortunately, the explanatory text was prepared by John Hunter and Matthew Baillie, who considered that the decidua represented a fibrinous exudate from the lining membrane of the uterus, which not only formed a complete cast of its cavity but also covered the tubal openings. They supposed, therefore, that when the ovum reached the uterine end of the tube its further passage was opposed by the decidua vera, which it was obliged to push before it as it entered the uterus, whence the term reflexa; consequently, after the latter had been pushed forward, a new exudate was developed behind the ovum, to which the term *serotina* (late) was applied (Figs. 140 and 141).

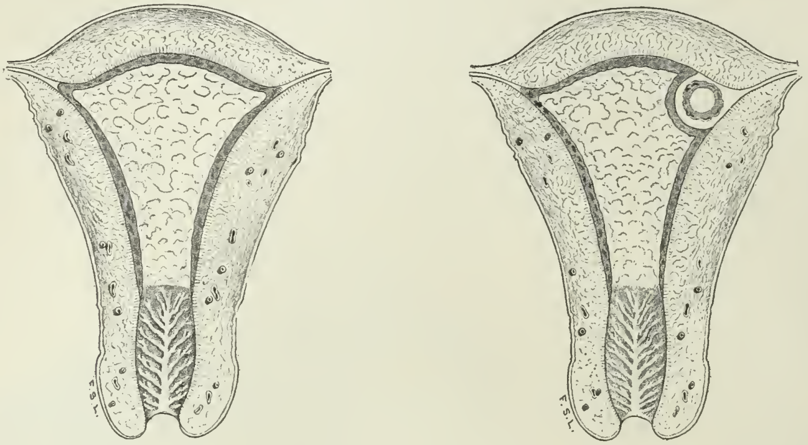


Fig. 140. Fig. 141.

Figs. 140, 141.—Diagrams Illustrating Hunterian Theory of Formation of Decidua Reflexa.

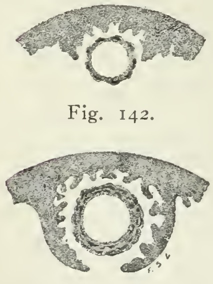


Fig. 142.

Fig. 143.

Figs. 142, 143.—Diagrams Illustrating Old Theory of Formation of Decidua Reflexa.

This conception was universally accepted until 1846, when Weber in Germany and Sharkey in England demonstrated that the decidua contained uterine glands, and consequently must be the altered endometrium. It having therefore become necessary to explain the formation of the reflexa in a different manner, it was assumed that the ovum, on reaching the uterus, found its entire cavity lined by decidua vera, to some point of which it became attached, and that immediately afterwards the vera began to proliferate about its margin and to form a wall around the ovum, until it had completely inclosed and surrounded it. Later investigation, in turn, showed that this view was not correct, as the ovum remains upon the surface for only a few hours, and then burrows into the depths of the decidua, as has already been described. Notwithstanding these new ideas, the terms reflexa and serotina are still employed, though in the new anatomical nomenclature they are more properly designated as the *decidua capsularis* and *basalis,* respectively.

1. Decidua Vera.—The microscopic structure of the decidua vera was first studied by Hegar and Maier, but it was not until the work of Friedländer, and Kundrat and Engelmann that its structure was definitely understood Friedländer, in 1870, pointed out that the decidua vera was composed of two portions: a *compact* layer superimposed upon a *spongy* or *glandular* layer, the latter adjoining the muscular wall of the uterus, and forming the main thickness of the membrane. He showed that the compact layer was made up of large round, oval, or polygonal cells, with large, lightly staining, vesicular nuclei—the *decidual cells,* while the spongy layer was composed of dilated and hyperplastic uterine glands. Furthermore, he formed the incorrect opinion that separation at the time of labor took place at the junction between the two layers.

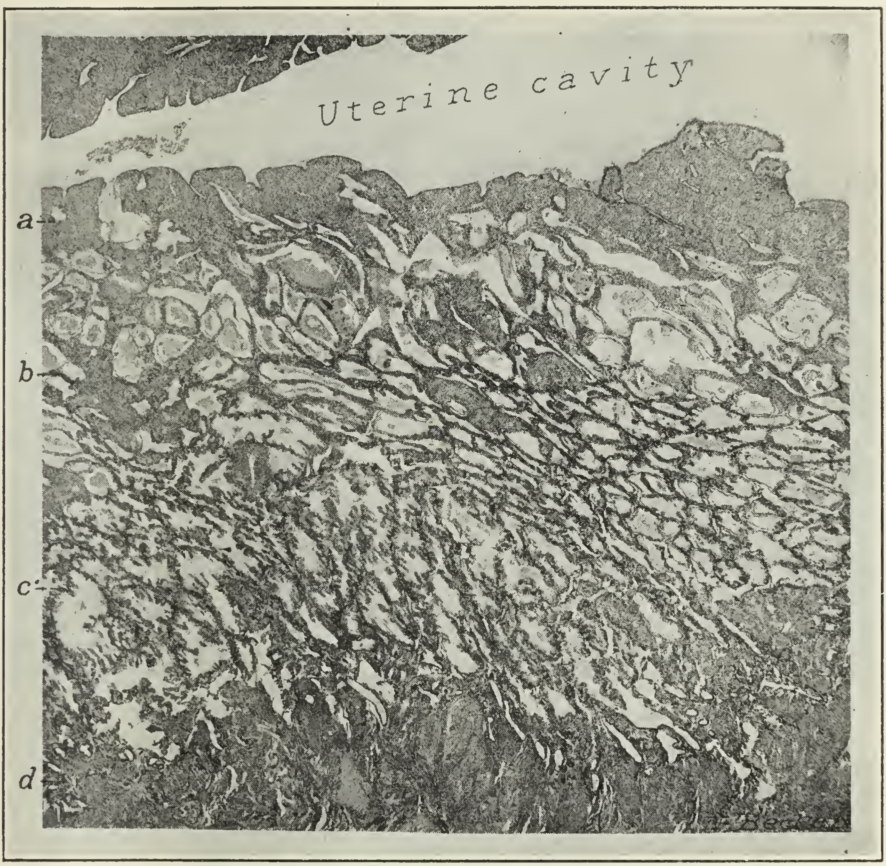


Fig. 144.—Early Decidua Vera. × 13.
a, compact layer; *b,* spongy layer; *c,* functional layer; *d,* muscularis.
(Compare with Figure 86, mucosa at onset of menstruation.)

The decidua vera increases markedly in thickness during the first three or four months of pregnancy, so that at the end of that time it may attain a thickness of about 1 centimeter. Figures 51 and 145 show very graphically the difference between the normal resting endometrium and the decidua vera from a uterus four months pregnant. After the fourth month, owing to the distention of the uterus, the vera gradually becomes thinner, so that at term it is rarely more than 1 or 2 millimeters thick.

Under the microscope the compact layer is seen to be made up of closely packed, large, oval, or polygonal cells, which are distinctly epithelioid in appearance, and possess round, vesicular nuclei, which stain but slightly with the ordinary reagents. When the tissue has been distended by hemorrhage or edema, it is seen that many of the decidual cells present a stellate appearance, and are provided with long protoplasmic outgrowths which anastomose with similar processes from neighboring cells. Particularly in the early months of pregnancy, one sees scattered between the typical decidual cells a considerable

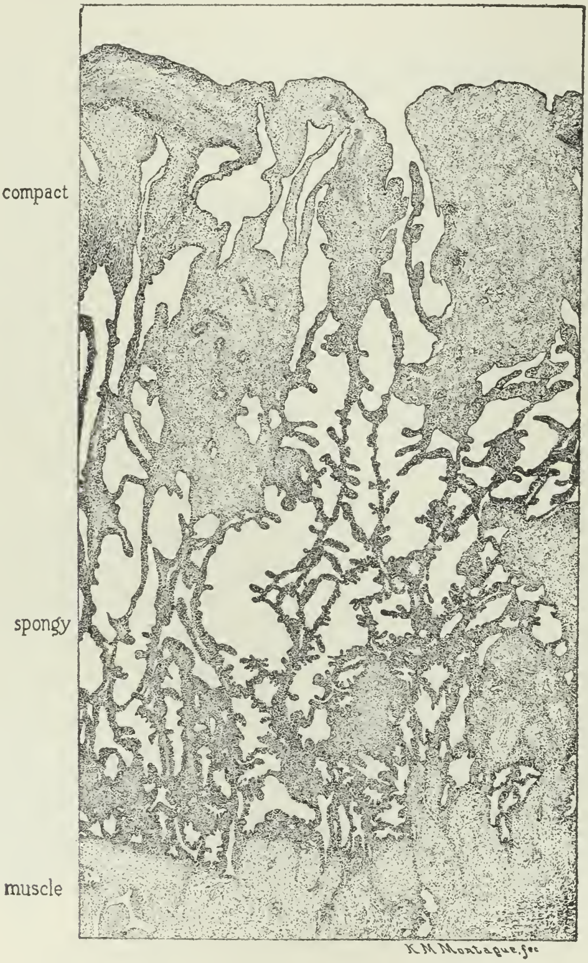


Fig. 145.—Decidua Vera, Fourth Month. × 16.

number of small round cells, whose bodies are almost entirely filled by the nucleus. Such cells were formerly considered as lymphoid in character, but Marchand and Rossi-Doria contend that they are forerunners of new decidual cells, basing their contention upon the fact that they frequently contain mitotic figures, and that all gradations may be observed between them. In the early months of pregnancy the ducts of the uterine glands may be seen traversing the compact layer, but they soon disappear, so that in the later months all trace of them is lost.

The spongy layer is made up of the distended and hyperplastic glands of the endometrium, which are separated from one another by a minimal amount of stroma. In many instances the glandular hyperplasia is so marked that the spongy layer suggests an adenoma in appearance. At first the glands are lined by typical cylindrical uterine epithelium, which presents evidence of abundant secretory activity. The material secreted probably serves as a pabulum for the ovum pending the establishment of the placental circulation. Later the epithelium gradually becomes cuboidal, or even flattened, in shape and, undergoing fatty degeneration, is cast off in great part into the lumina of the glands. Particularly toward the muscularis, the stroma between the dilated glands undergoes but little change, and closely resembles that of the nonpregnant uterus. For this reason, certain authorities divide the decidua into three layers—compact, functional and basal, and it is from the latter that the endometrium is regenerated after labor.

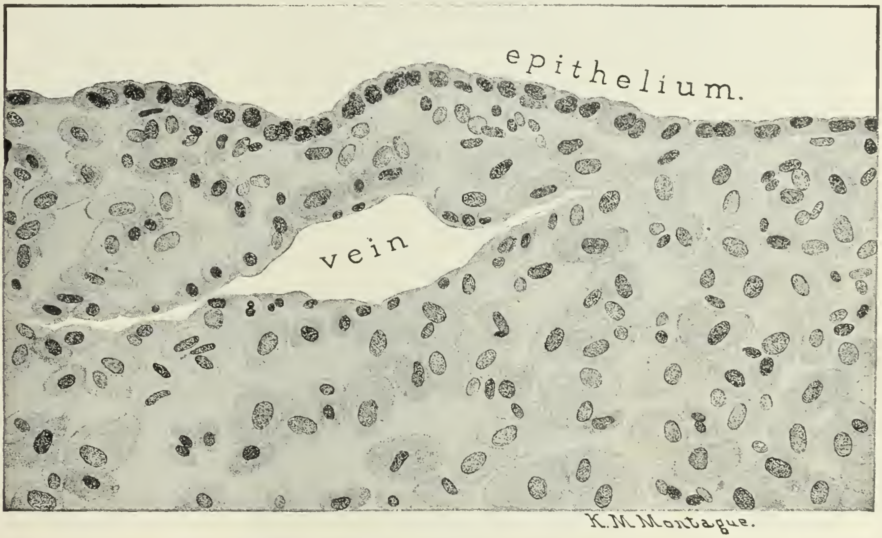


FIG. 146.—COMPACT LAYER OF DECIDUA VERA. FOURTH MONTH. × 420.

Under the influence of pregnancy, the surface epithelium covering the decidua soon loses its cylindrical shape and becomes cuboidal or flattened, sometimes even resembling endothelium. Klein first directed attention to this changed condition, and subsequently all observers have held that it is a characteristic microscopic evidence of pregnancy.

Figure 146 represents a section through the compact layer of the decidua vera at the fourth month, while Figure 52 shows a gland with its surrounding stroma from a nonpregnant endometrium, drawn under the same magnification. On comparing them, it is readily seen that the decidua differs from the latter by a marked increase in size of the stroma cells, and by a decrease in size of the epithelial cells. Schick in 1905 pointed out that the decidua is particularly rich in lymphatic spaces, and holds that in properly prepared specimens they occupy at least as much space as the hypertrophied glands.

As a result of the work of Hegar and Maier, Leopold, Minot, and others, it is now universally held that the decidual cells are derived from the stroma cells of the endometrium, which have undergone marked increase in size, but only slight increase in number. Ruge directed attention to the resemblance which they bear to sarcoma cells, and stated that "the decidual cell represents the physiological type of the sarcoma cell."

The connective-tissue origin of the decidual cell was established only after prolonged investigation, and, before it was definitely proved, various theories were advanced as to their origin: Hennig believing that they were derived from leukocytes, Frommel and Overlach from the uterine epithelium, and Ercolani from the endothelium of the blood vessels. At the present time these views are of interest only from an historical standpoint.

The connective-tissue origin has been further confirmed by the study of so-called ectopic decidua, in which typical decidual cells develop from the connective tissue on the posterior surface of the uterus, in the tubes or ovaries, as well as in the omentum or vermiform appendix, to which reference will be made in Chapter VI.

2. Decidua Capsularis.—Except for the first few hours after its entry into the uterus, the ovum is shut off from the rest of the uterine cavity by the decidua reflexa or capsularis, which forms a capsule of decidual tissue around it. Figure 139 shows an early pregnancy in which the reflexa is quite apparent, and Figure 147 a five or six weeks' pregnancy in which it is well developed.

During the early months of pregnancy the decidua capsularis does not entirely fill the uterine cavity, so that a space of varying size exists between it and the vera. This is well shown in Figure 149, which represents an eight weeks' pregnant uterus. At the fourth month of pregnancy, however, the growing ovum entirely fills the uterine cavity, so that the capsularis and vera are brought into intimate contact, and the part of the uterine cavity which had remained unoccupied up to that time becomes obliterated. In a short time the two structures fuse together, when the capsularis gradually degenerates and disappears. This view was first advocated by Minot, and appears to be well founded, inasmuch as sections through the wall of the full-term uterus outside of the placental site show that the entire decidua is only 1 to 2 millimeters thick, and no indication of the decidua capsularis can be discovered (Fig. 154).

The decidua capsularis usually attains its greatest thickness at about the second month. Sections through it at this time show that it is made up of decidual cells and is covered on its exterior by a single layer of flattened epithelial cells; while internally it is in contact with the fœtal villi, and at no time shows any trace of uterine epithelium. In its lowest portion, where it is connected with the vera, a few glands may be found, whose ducts, when present, are seen to open only upon the outer surface of the membrane.

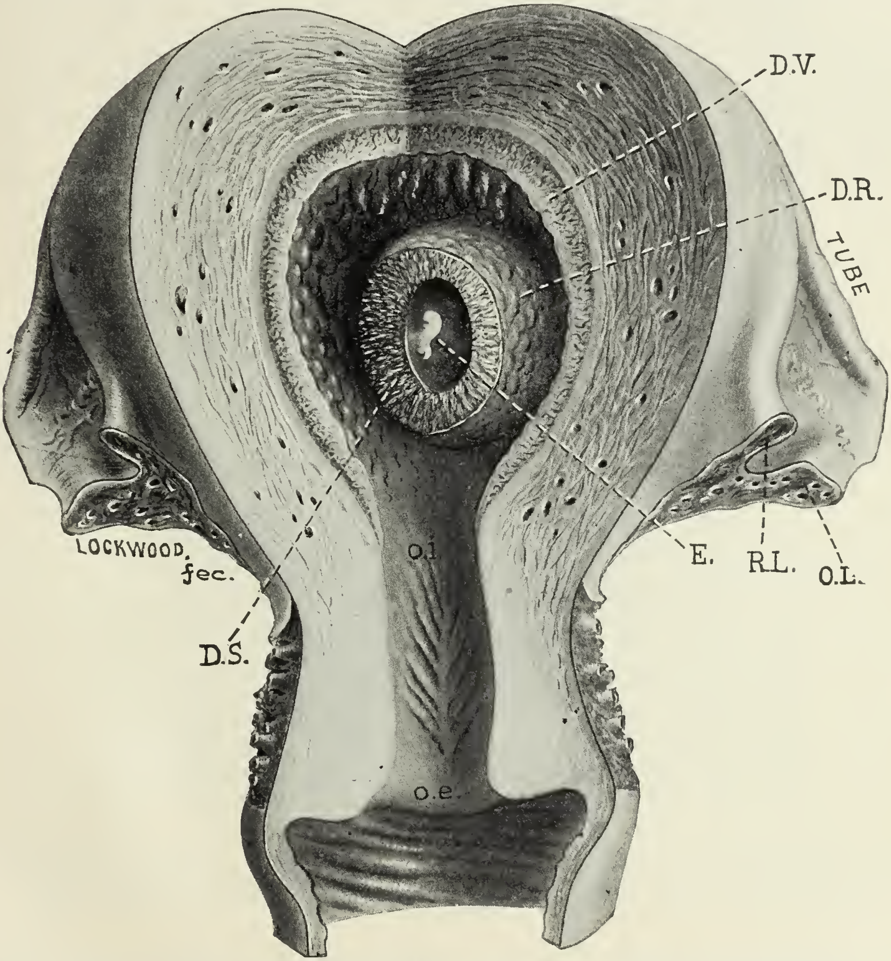


Fig. 147.—Five Weeks' Pregnant Uterus. × 1. (Anatomical Museum, Johns Hopkins University.)

DR., decidua reflexa; *D.S.*, decidua serotina; *D.V.*, decidua vera; *E*, embryo; *O.L.*, ovarian ligament; *R.L.*, round ligament. Embryo drawn relatively too large.

Until the present century, it was universally believed that the capsularis originated from the proliferation of the vera, which grew up around and gradually inclosed the ovum. More accurate knowledge concerning the mode of implantation of the ovum, however, shows that this is not the case, but that the capsularis is merely the portion of the decidua vera which shuts off the embedded ovum from the uterine cavity, and, except in certain pathological conditions, it has fulfilled its function when it comes in contact and fuses with the decidua vera.

3. Decidua Basalis.—The decidua basalis or serotina is the portion of the decidua which lies immediately beneath the ovum; from it the maternal portion of the placenta is developed. Broadly speaking, it presents the same general structure as the decidua vera, except that it has been invaded by fœtal tissue, so that its superficial portions are composed of fœtal ectoderm, as well as decidual cells, and frequently of fibrinous degenerative areas to which reference will be made later.

Friedländer and Leopold stated in their original monographs that giant cells appeared in the basalis about the middle of pregnancy. These, they thought, made their way into the vessels and gave rise to thrombosis. Their interpretation, however, is no longer accepted, and it is now known that the so-called giant cells are not of decidual origin, but represent portions of trophoblast, which have invaded the decidua. Figure 150, representing a section through the decidua basalis in the last month of pregnancy, shows clearly that its superficial portions are composed of a mixture of both fœtal and maternal cells.

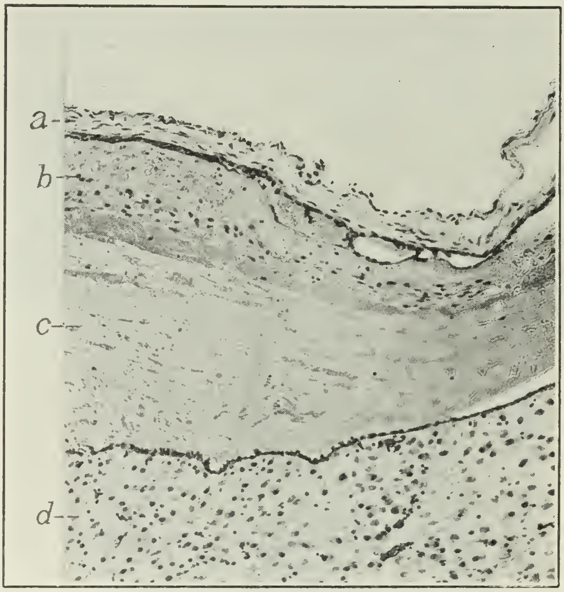


Fig. 148.—Unfused Decidua Vera and Capsularis.
Section through 10-week pregnant uterus, showing that the decidua vera and capsularis have not yet fused. × 1.
a, amnion and chorionic membrane; *b,* degenerated decidua capsularis; *c,* uterine cavity; *d,* decidua vera.

In the decidua basalis large numbers of blood vessels are observed. The arteries pursue a spiral course, and usually penetrate the entire thickness of the membrane; while many of the veins become markedly dilated and form large sinuses. In Figure 150 two small vessels may be seen which, after pursuing their course through the superficial layer of the serotina, open into the intervillous spaces of the placenta. The consideration of the vascular connections between the fœtus and the uterus, however, will be deferred until we take up the study of the placenta.

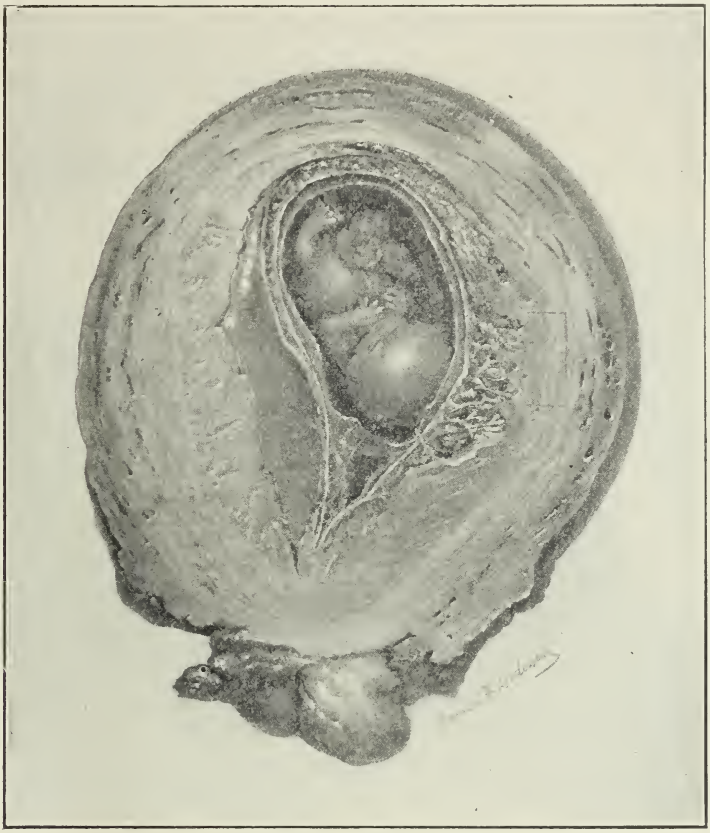


Fig. 149.—Sagittal Section of an Eight Weeks' Pregnant Uterus, Slightly to One Side of the Middle. × 1.

Note the early placenta on right and thick decidua vera on left side. The embryo lies in the amniotic cavity, outside of which is the chorion and the decidua capsularis. The remnant of the uterine cavity lies between the decidua vera and capsularis. (Specimen from the Department of Embryology of the Carnegie Institution.)

D. Structure of the Placenta in the Early Months.—The mode of implantation of the ovum has already been described, and it is generally believed that it usually occurs upon the upper portion of either the anterior or posterior wall of the uterus, and only exceptionally upon its lower portion. The ovum is very rarely implanted at the fundus or in the angles, since in these locations the decidual reaction is much less pronounced than elsewhere. After the ovum has burrowed into the depths of the decidua, the portion separating it from the uterine cavity is known as the capsularis, and that beneath it as the basalis.

Almost immediately it becomes converted into a blastodermic vesicle, whose outer ectodermal covering, which is now designated as the trophoblast, at once begins to proliferate and invade the surrounding decidual tissue. As it does so, it breaks through the walls of maternal capillaries, from which the blood escapes and forms cavities, which are bounded partly by trophoblast and partly by decidua (Plates IV and V). As the process goes on more vessels are opened up, so that in a short time the trophoblast presents a sievelike appearance due to the presence of large numbers of blood spaces filled with maternal blood. As a result, the trophoblastic cells become compressed into irregularly shaped masses of varying size, some of which extend from the surface of the ovum to the surrounding decidua, and afford the epithelial basis from which the fastening villi are developed.

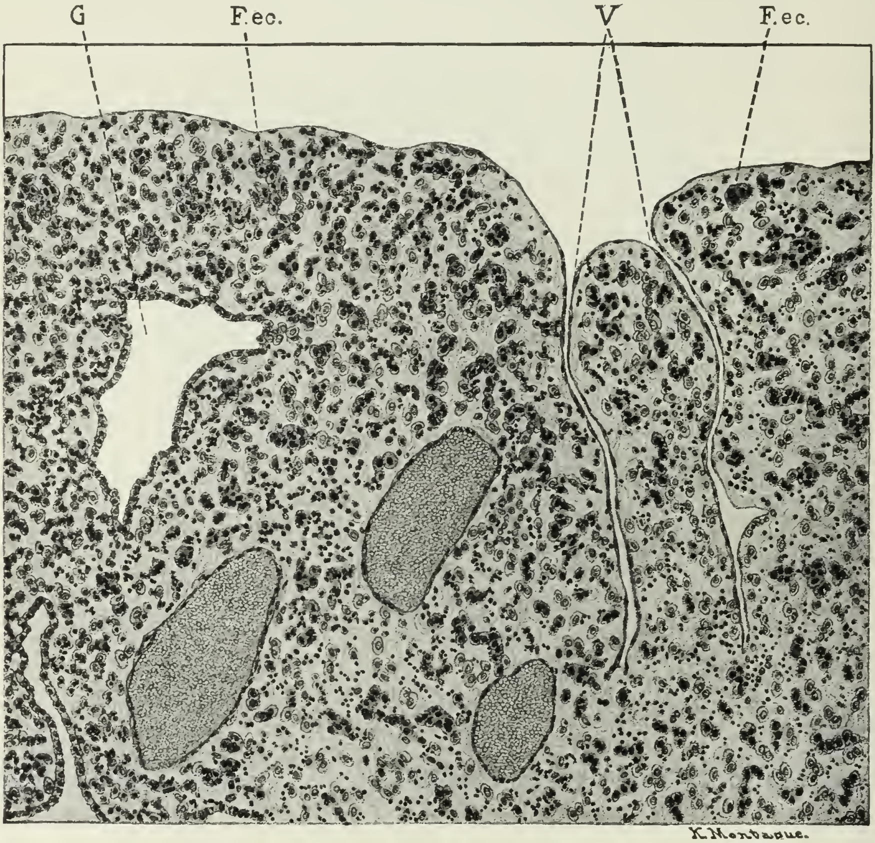


Fig. 150.—Decidua Basalis, Showing Mixture of Fœtal and Maternal Cells. × 75. *G.*, gland; *F.ec.*, fœtal ectoderm; *V.*, vessel.

The maternal blood spaces established in this manner represent the earliest stages in the formation of the *intervillous blood spaces* of the future placenta, and are abundantly present in the early ova recently studied. Coincidentally with their formation, the trophoblastic masses are invaded by connective-tissue offshoots from the chorionic membrane, and are thus converted into *villi,* whose epithelial covering becomes arranged in the characteristic two layers.

During the early weeks of pregnancy branching villi project from the entire periphery of the ovum, as is well seen in Figures 133 and 134. They come in contact not only with the decidua basalis, but also with the capsularis, so that for a time intervillous blood spaces surround the entire ovum. As the chorionic villi are devoid of blood vessels for the first few weeks, the ovum must be nourished during that period by osmosis from the maternal fluids.

As pregnancy advances, the blood supply of the decidua basalis becomes more and more abundant, while that of the capsularis diminishes; as a consequence the villi in contact with the former are better nourished and grow more luxuriantly, and it is these which take part in the formation of the placenta. Over the rest of the surface of the ovum the villi develop less rapidly, and eventually atrophy, giving rise to the *chorion læve.* As the ovum increases in size, the intervillous spaces in the chorion læve become smaller and smaller, and by the fourth month, when the decidua reflexa has come in contact with the vera, they become obliterated, and the corresponding villi undergo degeneration, but do not completely disappear. For, even at term, sections through the uterine wall (Fig. 154) show that the chorion læve consists of several layers of chorionic epithelium, through which are scattered round or oblong hyaline bodies, in which a few spindle-shaped nuclei can be distinguished. These are the remains of the earlier villi. At the same time degenerative changes take place where even the chorionic epithelium comes in contact with the decidual tissue, which result in the formation of fibrinlike material which will be considered in detail later. On the other hand, the villi of the chorion frondosum increase in size and number, and the blood vessels which originate within them become connected with branches of the umbilical vessels of the embryo, so that after the first few weeks the fœtal circulation extends to the tips of the smallest villi.

The *placenta* is formed by the union of the chorion frondosum and the decidua basalis, and therefore is composed of both fœtal and maternal tissues. It soon constitutes a distinct structure, although its site is indicated at a still earlier period by the point of attachment of the abdominal pedicle to the inner surface of the chorionic membrane. According to Benoist, its weight exceeds that of the fœtus for the first three and a half months of pregnancy.

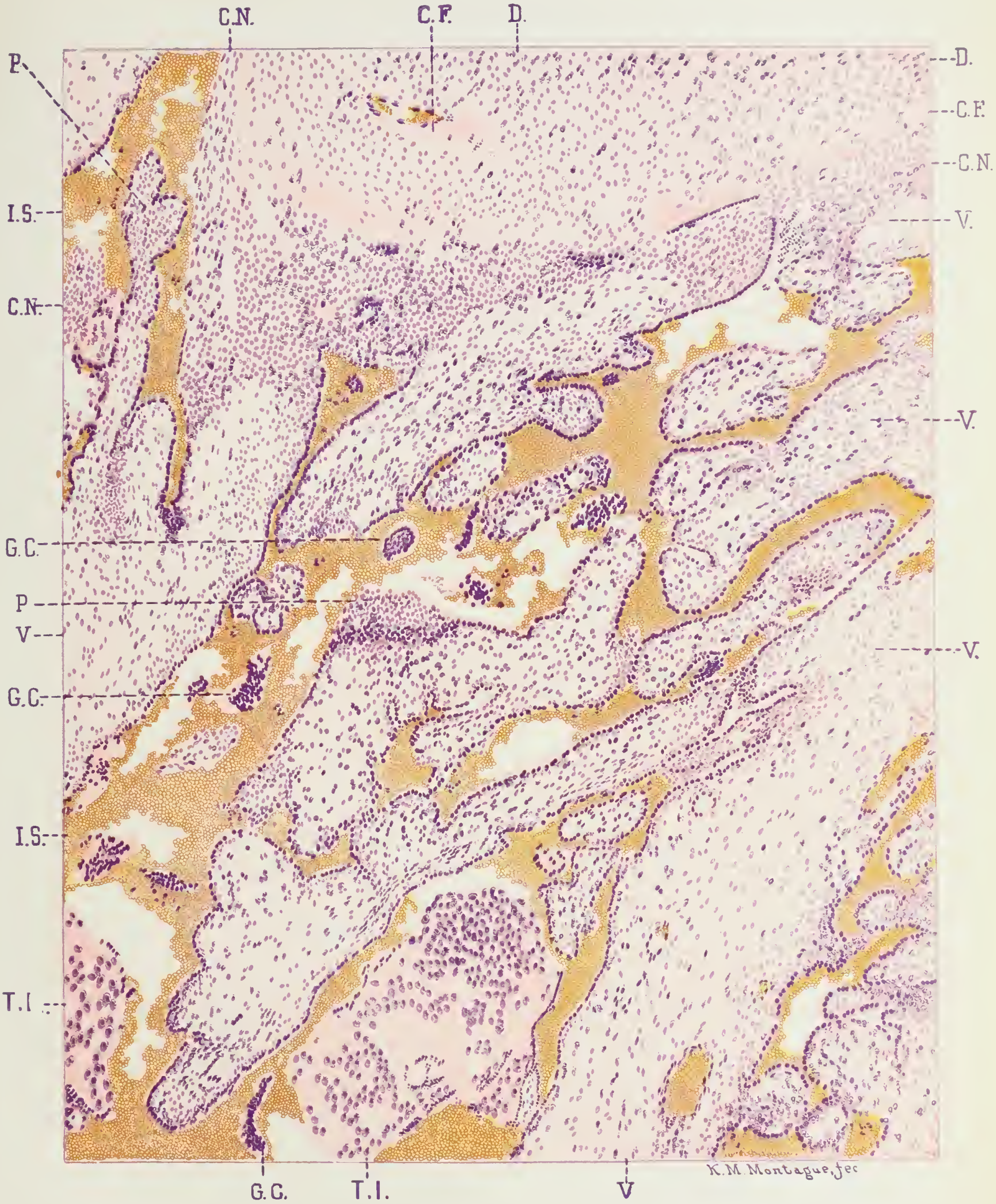
One can probably best understand the structure of the placenta by studying sections through it at various periods of pregnancy. One from the fourth month is reproduced in Plate V, and shows that the organ is made up in great part of chorionic villi, whose stroma presents a somewhat mucoid appearance, and contains spindle- and star-shaped connective-tissue cells, between which well-developed arteries, veins, and capillaries may be observed. At this stage the villous epithelium is arranged in two layers—Langhans' layer and the syncytium—and from the latter many buds protrude, which, when examined in cross or tangential section, appear as giant cells lying free in the intervillous spaces.

In the upper part of the plate is the decidua basalis, with which are connected some of the *fastening villi,* which extend from the chorionic membrane through the entire thickness of the placenta. At their ends can be noted a marked proliferation of ectodermal cells, which invade the underlying decidua, giving rise to the *cell nodes* or *cell columns,* and corresponding to the trophoblastic proliferation of the early days of pregnancy. The cell nodes are composed almost exclusively of Langhans' cells, as the syncytium does not follow them down into the depths of the decidua. The great majority of the villi, however, do not reach the decidua, but end freely in the intervillous space. The space between the chorionic membrane on the fœtal side and the decidua basalis on the maternal side, which is not occupied by villi is designated as the placental or intervillous space. These spaces are filled with maternal blood and their walls are lined by syncytium. Scattered through them are isolated giant cells—the so-called placental giant cells—whose origin has already been considered. Here and there are seen a few large areas composed of cuboidal or polygonal cells with vesicular nuclei, which frequently present signs of degeneration. These are the so-called trophoblastic islands, which represent masses of trophoblast which have not received a core of connective tissue and therefore have not developed into typical villi. As they contain no vessels and are nourished solely by osmosis from the maternal blood contained in the intervillous spaces, they are very prone to degenerative changes and play a considerable part in the production of placental lesions, which will be considered in their appropriate place. They were formerly called decidual islands, and were supposed to represent sections through decidual septa, which projected from the decidua basalis toward the chorionic membrane. With our present knowledge of the development of the placenta such a view is only rarely tenable.

At the junction between the fœtal and decidual tissue, areas are noted which stain deeply with eosin, and which, on closer examination, are seen to be made up of fibrinoid material, honeycombed in various directions by small spaces—*canalized fibrin.* This results from the degeneration of both fœtal and decidual cells, and is known as Nitabuch's layer, from the author who first called attention to its presence in the decidua. Its existence has been confirmed, and its characteristics have been studied by Langhans, Rohr, and others. It would seem that degenerative changes of this type occur wherever fœtal and maternal tissues come in contact, and the phenomenon suggests that a very important function of the decidua is to protect the maternal organism against invasion by fœtal cells. That this is not a fanciful conception is shown by the fact that whenever the decidual reaction is defective or lacking the growing villi may invade the maternal tissues almost like a malignant growth. This is observed in tubal pregnancy, in placenta accreta, as well as certain rare cases of spontaneous rupture of the uterus.

Until comparatively recently the participation of fœtal tissue in the decidua basalis was not recognized. Furthermore, it was formerly considered that the cells covering the maternal surface of the chorionic membranes were decidual

PLATE V.


C.N.
C.F.
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K.M. Montague, fec

SECTION THROUGH FOUR MONTHS' PLACENTA, SHOWING JUNCTION OF CHORION AND DECIDUA. × 56.

C. F., canalized fibrin; *C. N.*, Cell nodes; *D.*, decidua basalis; *T. I.*, trophoblastic island; *G. C.*, giant cell; *I. S.*, intervillous space; *P.*, proliferating villous epithelium; *V.*, chorionic villi.

in origin, and it was held that decidual tissue extended from the margins of the decidua basalis over the whole of the maternal surface of the chorionic membrane, so that the entire intervillous space was included between decidual or maternal tissue. Winckler, accordingly, designated the superficial portion of the decidua as the *basal,* and the portion covering the chorionic membrane as the *closing* plate of the decidua. As it has already been shown that the tissue in question is composed of fœtal ectoderm, the conception of decidual plates must be abandoned.

It is generally believed that maternal blood is slowly, but constantly circulating through the intervillous spaces, although Stoeckel, in 1928, expressed some scepticism concerning its actual circulation. At one point in Plate V a maternal vessel is seen opening directly into the intervillous space, with the tip of the villus marked "p" projecting into its lumen. This is not uncommon, as the ends of villi may grow for a considerable distance into vessels. In such circumstances it has long been known that portions of villi may become broken off, and thus gain access to the general circulation. Veit has designated the process as deportation, and upon it has constructed a theory explaining most of the abnormalities of pregnancy, to which reference will later be made.

It should be remembered that during the first eight or ten weeks of pregnancy the red blood cells of the fœtus are nucleated, but afterwards the nuclei are lost. The fœtal blood in the chorionic vessels at no time mixes with the maternal blood in the intervillous spaces, and during the first half of

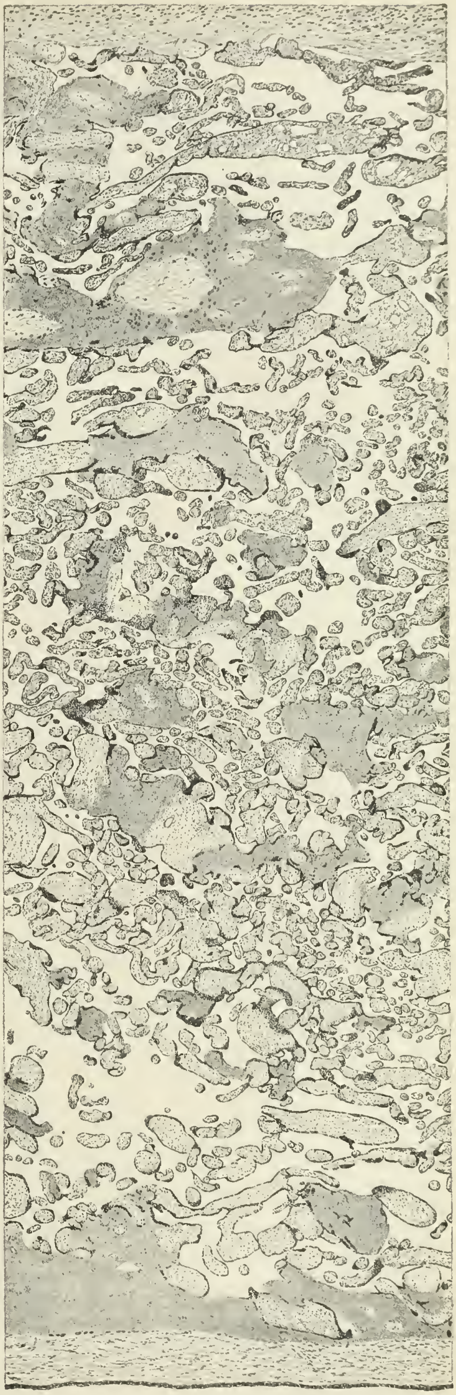


Fig. 151.—Section through Placenta at Eighth Month. × 15.

pregnancy the two are separated from each other by the double layer of chorionic epithelium, a portion of the stroma of the villus, and the vessel walls.

Structure of Placenta in Latter Half of Pregnancy and at Full Term.—Except in its increased size, the placenta in the second half of pregnancy differs but slightly from that of the fourth month. Microscopic sections at this period, however, show certain points of difference. These are well illustrated in Figure 151, which represents a section through a seven and a half months' placenta and the adjacent decidua. Studying it from below upward, we see that it is composed of the following structures: amnion, chorionic membrane, villi, intervillous spaces, and decidua basalis.

The amnion covers the inner or fœtal surface of the placenta, and consists of a single layer of cuboidal epithelium, below which comes a layer of more or less fibrillar connective tissue, containing no blood vessels. The chorionic membrane presents essentially the same structure as in the earlier months of pregnancy, differing only in the presence of a large amount of canalized fibrin immediately beneath its epithelium, as well as in the presence of larger vessels.

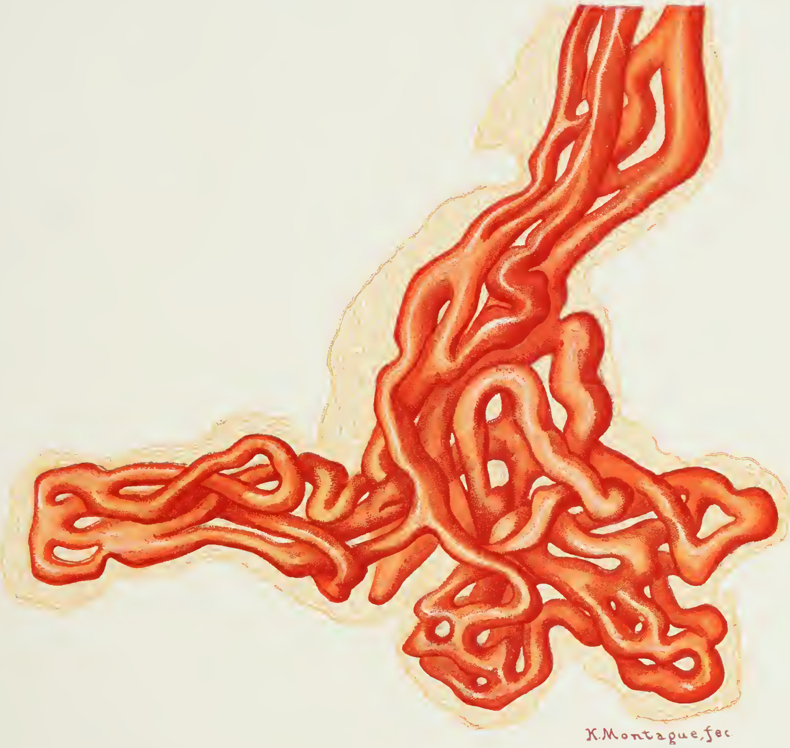
The great bulk of the placenta is made up of chorionic villi, whose branches are much more abundant, but at the same time considerably smaller, than at the fourth month. Their stroma, which is made up of spindle-shaped cells, is denser, is occupied in great part by blood vessels, and differs materially from the mucoid tissue of the earlier months. These changes have already been referred to, and are clearly shown in Figure 138.

The epithelium covering the villi has also undergone marked change; Langhans' layer has disappeared and there remains only a thin layer of syncytium, which gives rise to fewer buds than previously. In many villi immediately under the epithelium, and occupying the former position of Langhans' cells, a thicker or thinner layer of canalized fibrin may be observed. This was first described by Langhans, is of constant occurrence in the latter half of pregnancy, and is probably indicative of senility of the organ. At the same time, many of the arteries present all stages of an obliterating endarteritis, to which, in part, the formation of the tissue in question should be attributed.

The superficial portion of the decidua at this period is covered by a layer of canalized fibrin of varying thickness, which probably results from the necrosis following the contact of fœtal trophoblast with maternal decidua. In the deeper layers numerous giant cells are observed, which occasionally extend deeply into the connective-tissue septa between the muscle fibers. They are of various shapes, and represent portions of trophoblast which have wandered down into the decidua.

From the free surface of the decidua numerous elevations of varying shape and size extend for a greater or lesser distance toward the chorionic membrane —the trophoblastic or, as they were formerly designated, the decidual septa. These are composed of cuboidal or polygonal cells with round, vesicular, deeply staining nuclei, and represent masses of trophoblast which have not been con-

PLATE VI.


K.Montague, fec

TERMINAL CHORIONIC VILLUS, WITH INJECTED VESSELS.

verted into villi. Owing to the absence of blood vessels they are very prone to degenerative change and tend to become converted into canalized fibrin, or to lead to the formation of small cystic structures.

The space between the chorionic membrane and the free surface of the decidua basalis is designated as the *placental space;* into this the chorionic villi dip, thereby subdividing it into myriads of irregularly shaped cavities which communicate freely with one another—the intervillous spaces. These are lined throughout by syncytium, except where it has given place to canalized fibrin. The syncytium is thinner than in the earlier months, and under suitable magnification its protoplasm presents a vacuolated appearance, which, according to Marchand, is due to the glycogen normally contained in it having been dissolved out by the fluids used in hardening the tissue.

The intervillous spaces are at no time lined by endothelial cells, and it is probable that what had formerly been described as such in reality represents thinned-out syncytium. Hence, it would appear that the intervillous spaces are lined entirely by fœtal tissue, and that the maternal blood, which is circulating through them, lies outside of the body of the mother. The maternal blood gains access to the placental space by branches of the uterine arteries, which pursue a convoluted course through the decidua basalis and, after their walls have gradually become reduced to a single layer of endothelium, open upon the sides of the decidual septa. The blood escapes from the intervillous spaces through more or less funnel-shaped openings upon the surface of the decidua, which can be traced directly into large venous sinuses in its depths. Consequently, there must be a distinct circulation through the intercommunicating intervillous spaces, though it is necessarily very sluggish. Grosser believes that it is maintained entirely by the intermittent contractions of the uterine muscle, as he holds that the terminal ends of the uterine arteries are so thinned out that a *vis a tergo* cannot be concerned. Wagner, on the other hand, contends that the pulsation of the fœtal vessels is the main factor concerned.

The nature of the *intervillous spaces* and the question as to whether they contain maternal blood have given rise to a great deal of discussion. Vater, Noortwyk, and William and John Hunter, in 1754, expressed an affirmative opinion; and the last two investigators demonstrated it by injection experiments. Similar results were obtained by E. H. Weber, in 1842. But this work was gradually lost sight of, and all sorts of theories were evolved concerning their nature. Braxton Hicks, Ercolani, and others believed that they contained so-called uterine milk, which was secreted by the mucous membrane of the uterus. Such a statement is correct for the pig and cow, but is incorrect for woman, and forcibly demonstrates the fallacy of drawing inferences from conditions observed in other species. Correct conceptions were finally established by the work of Farre, Turner, Waldeyer, Bumm, Leopold, and others, who showed conclusively that vessels of the mother could be traced into the intervillous spaces. This was especially well demonstrated by Waldeyer, who, in pregnant cadavers, was able to inject the intervillous spaces from the maternal vessels.

Furthermore, the study of early ova in situ has placed the question beyond all reasonable doubt.

In view of these facts, then, the placenta must be regarded as a collection of maternal blood, included between the chorionic membrane and the decidua basalis, into which the villi dip and by which they are surrounded. Some idea of the complexity of its vascular arrangement may be gained from Plate VII, which represents a corrosion preparation of the fœtal portion of a full-term placenta, which was injected through the umbilical arteries and veins with red and blue celloidin. Jonen states that the capacity of the intervillous space varies greatly, and places the lower and upper limits at 90 and 330 cubic centimeters, respectively. It would appear that the complicated arrangement of the villi is a device by which the greatest possible area of chorionic tissue can be exposed to the maternal blood within a small space, and Dodds and Reck have calculated that the exposed surfaces of the villi equal an area of approximately 6½ square meters.

Normally there is no communication between the fœtal blood contained in the chorionic villi and the maternal blood in the intervillous spaces, and it would appear that the transmission of substances from one to the other is accomplished partly by osmosis and partly by the direct cellular activity of the chorionic epithelium, the details of which will be considered in the chapter on the physiology of the fœtus.

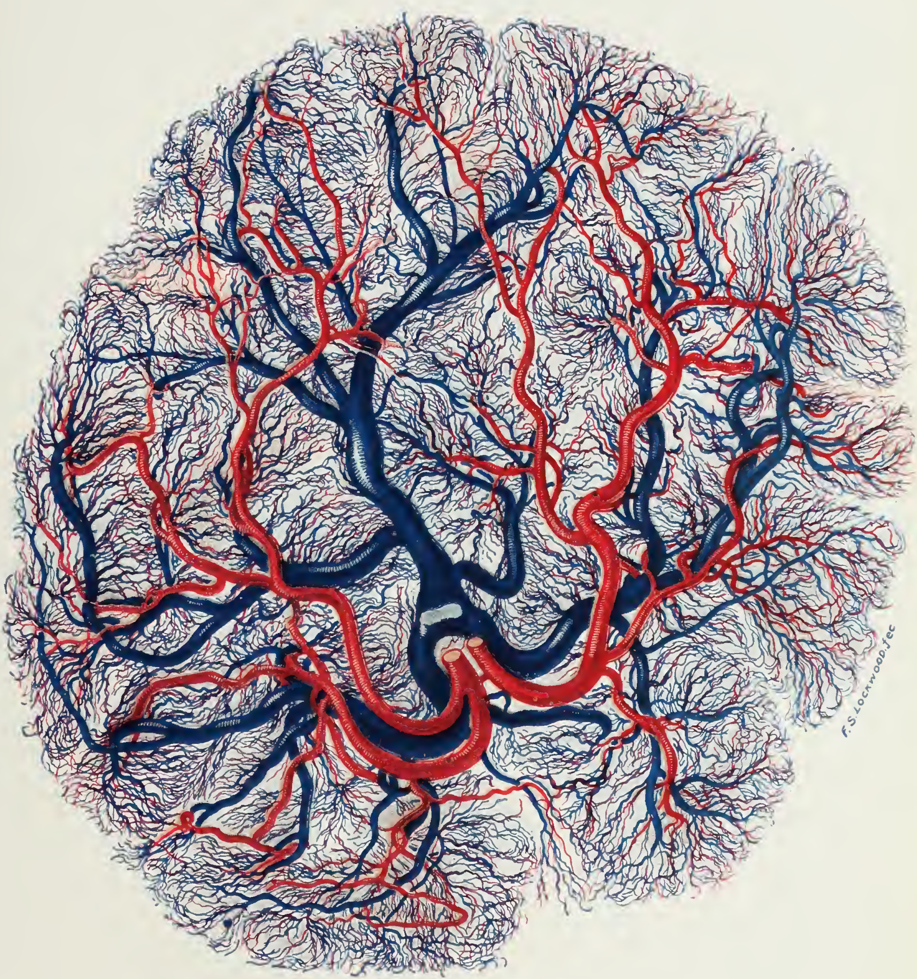
Since the time of C. Bernard glycogen has been observed in various portions of the placenta—decidua, villi, chorionic membranes and ammion. The researches of Flesch, Todyo and others show that it is most abundant during the first two months of pregnancy, but that traces persist even at term.

Soon after the discovery of folliculin by Allen and Doisy, it was found that a similar hormone is elaborated by the epithelium of the chorionic villi, so that in the latter part of pregnancy much greater quantities of it are produced by the placenta than by the ovaries. Consequently, it must be admitted that in addition to its other functions, the placenta acts as an important internal secretory organ. Full literature concerning these biological functions of the placenta will be found in Mayer's report.

In 1929 and 1930, Doisy, Veler and Thayer in a preliminary communication stated that they had been able to extract folliculin in crystalline form from the urine of pregnant women, and Collip announced that he had likewise isolated crystals of an ovary stimulating hormone from the placenta. These workers state that such preparations are extraordinarily potent, and Doisy claims that one milligram of his crystals contains 2000 cat units of folliculin. Detailed statements concerning the mode of preparation of these hormones have not yet been published, nor has their chemical constitution been established. It, however, appears probable that in the near future our knowledge along such lines will be greatly increased.

The After-Birth.—The placenta, as it is cast off from the uterus after the birth of the child, is a flattened, roundish, or oval organ—15 to 20 centimeters

PLATE VII.


F. S. LOCKWOOD. fec

CORROSION PREPARATION OF MATURE PLACENTA, TO SHOW FŒTAL VESSELS. × ¾.

in diameter, and 2 to 3 centimeters in height at its thickest part—from the margins of which the membranes extend. Ordinarily its weight is about ⅙ of that of the fœtus, so that when the latter is normally developed the placenta weighs from 500 to 600 grams.

It presents for examination two surfaces and a margin—the surface which was in contact with the decidua basalis being designated as the maternal or outer, and that directed toward the cavity of the ovum as the fœtal or inner surface. The former is covered by a thin layer of decidua and presents a ragged, torn appearance, being divided by depressions of varying depth into a number of irregularly shaped areas, the so-called *cotyledons,* which vary considerably in number, as many as twenty being sometimes observed. On careful examination of the decidual surface, numerous vessels may be seen which have been torn through when the placenta was separated. These were first observed by John Hunter, and Klein was able to count 51 arteries and 53 veins in a single specimen.

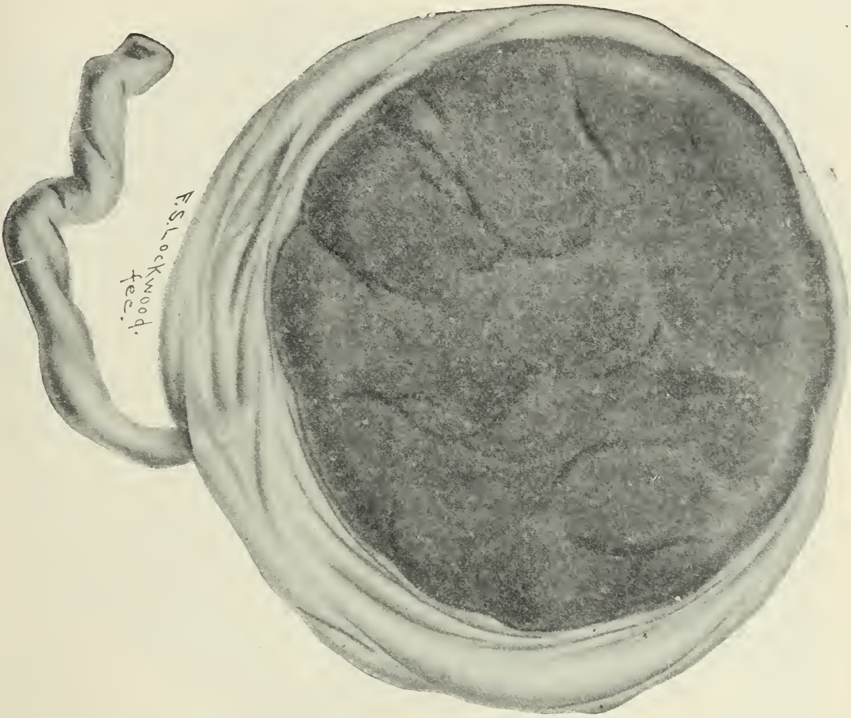


Fig. 152.—Maternal Surface of Mature Placenta, Showing Cotyledons; Membranes Turned Back. × ⅔.

The fœtal or inner surface presents a glistening appearance, owing to the fact that it is covered by amnion, which, however, is only slightly adherent. When the latter is removed it leaves a coarsely granular surface, upon which the umbilical cord is usually inserted somewhat eccentrically, though it may be just at the center of the organ or near its margin. The various modes of insertion will be considered when we take up the abnormalities of the placenta.

The vessels composing the umbilical cord spread out beneath the amnion and rapidly divide, but the main branches remain upon the fœtal surface of the placenta until its margin is reached. In many instances a large vein, which is known as the circular sinus, extends around a portion of the periphery of the placenta, but only rarely completely encircles it.

The *fœtal membranes* extend from the margins of the placenta, and consist of the amnion, chorion, and a thin layer of decidua. The amnion, the innermost of the membranes, is a thin, transparent, glistening structure, which is rarely thicker than a sheet of writing paper. Its outer surface is closely applied to the chorion, from which, however, it can usually be separated without difficulty. The chorion is more opaque and thicker than the amnion, though it rarely exceeds 1 millimeter in thickness. It represents the chorion læve of the early months, and under the microscope is seen to possess a number of degenerated villi. Clinging to its outer surface are a few shreds of decidual tissue, which are all that is cast off immediately after the birth of the child. Figure 154 represents a section through the fœtal membranes and the uterine wall outside of the placental site, and gives a good idea of their composition.

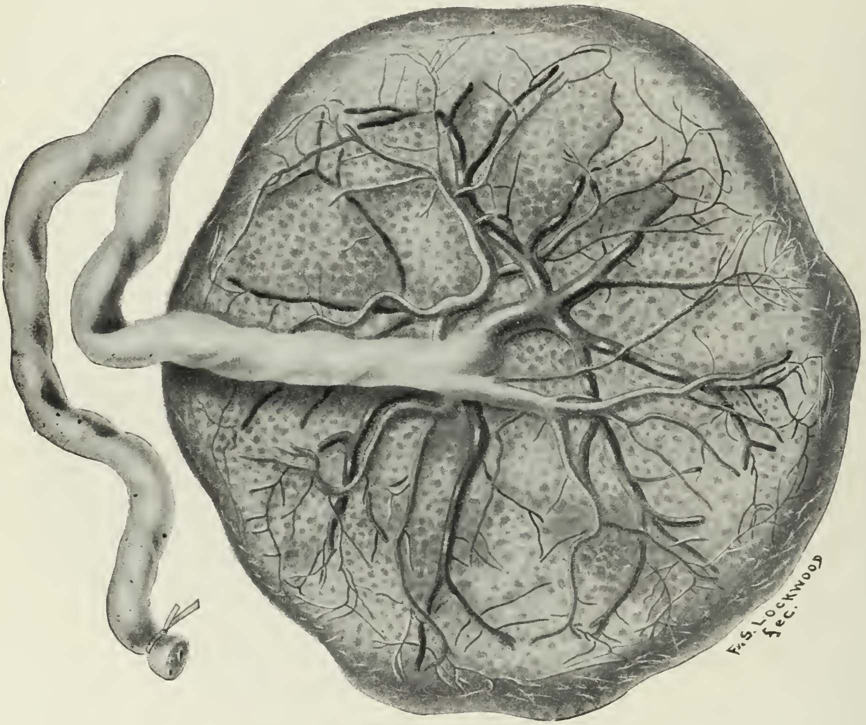


Fig. 153.—Fœtal Surface of Mature Placenta. × ⅔.

Umbilical Cord.—The umbilical cord, or funis, extends from the navel of the child to the fœtal surface of the placenta. Its exterior presents a dull white, moist appearance, and through it shimmer the umbilical vessels—two arteries and a vein. It varies from 1 to 2.5 centimeters in diameter, and averages about 55 centimeters in length; though in extreme cases it may vary from 0.5 to 198 centimeters. The average length of 1000 cords, which I measured, was 55 centimeters, the shortest being less than 1 and the longest 100 centimeters.

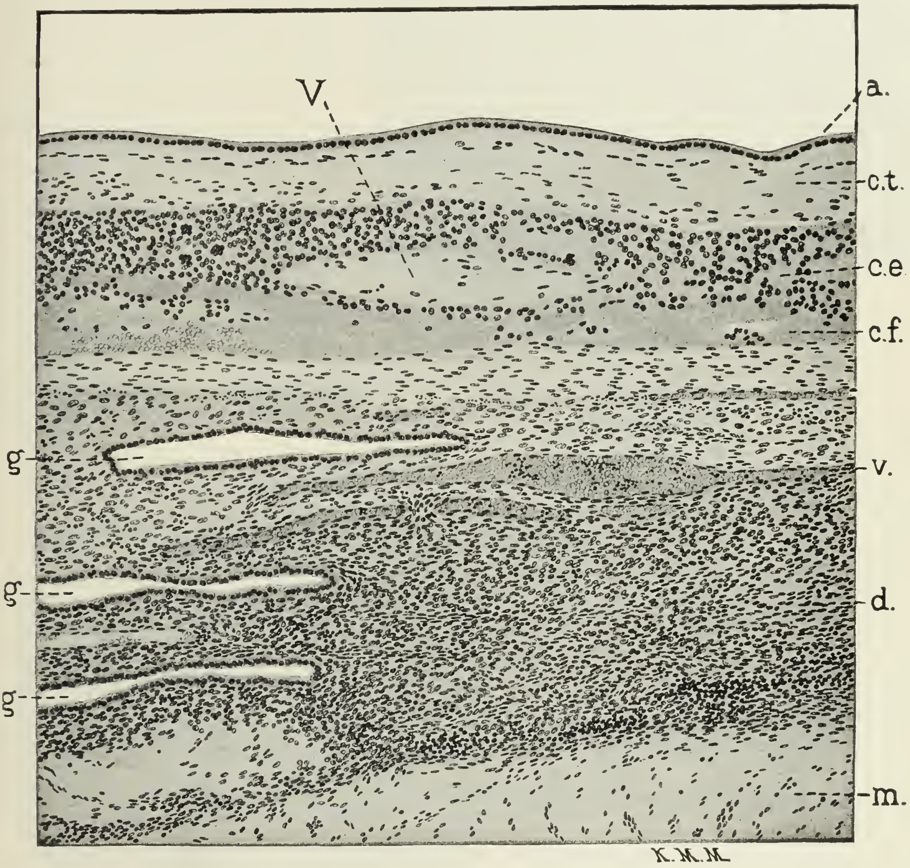


Fig. 154.—Fœtal Membranes and Uterine Wall. × 75.
a., amnion; *c.t.*, connective tissue of amnion and chorion; *c.e.*, chorionic epithelium; *c.f.*, canalized fibrin; *d.*, decidua; *g.*, gland; *m.*, muscularis; *v.*, vein; *V.*, atrophic villus.

The cord frequently presents a twisted appearance, the coiling usually being from left to right. As the vessels are usually longer than the cord, they are frequently folded upon themselves, thus giving rise to nodulations upon the surface which are designated as false knots.

The cord is covered by a sheath of amnion which is closely adherent to it. Under the microscope, the covering epithelium usually consists of a single layer of flattened cells, although occasionally it is arranged in several layers resembling those of the skin. Except for the large vessels, for according to Runge it possesses no capillaries, the interior of the cord is made up of a mucoid connective tissue—the so-called whartonian jelly.

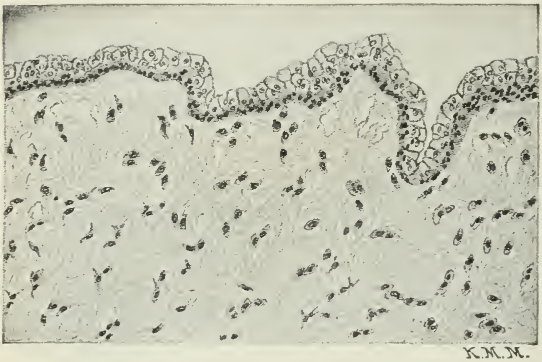


FIG. 155.—EPITHELIUM OF UMBILICAL CORD. × 110.

On microscopic examination of sections through any portion of the cord, one generally finds near its center a small darkly-staining area, which under higher magnification appears as a small duct lined by a single layer of cuboidal or flattened epithelial cells, and surrounded by a zone of relatively dense connective tissue. This is the duct or stalk of the umbilical vesicle. On the other hand, in sections taken just beyond the umbilicus of the fœtus, one occasionally finds a second duct, which represents the remnant of the allantois, but this is never found at the maternal end of the cord.

Formerly it was taught that the cord was derived from the allantois, but since the researches of His it has been generally recognized that such is not the case in man. In the youngest human ova, in which the embryo consists merely of a minute amnion and yolk sac, it is connected with the inner surface of the chorionic membrane by a thick mass of mesodermic or connective tissue, which His designated as the abdominal pedicle or body stalk, and which, after increasing in length and receiving a covering of amnion, becomes converted into the umbilical cord. Furthermore, the allantois in man at no time develops into the imposing organ which it becomes in many

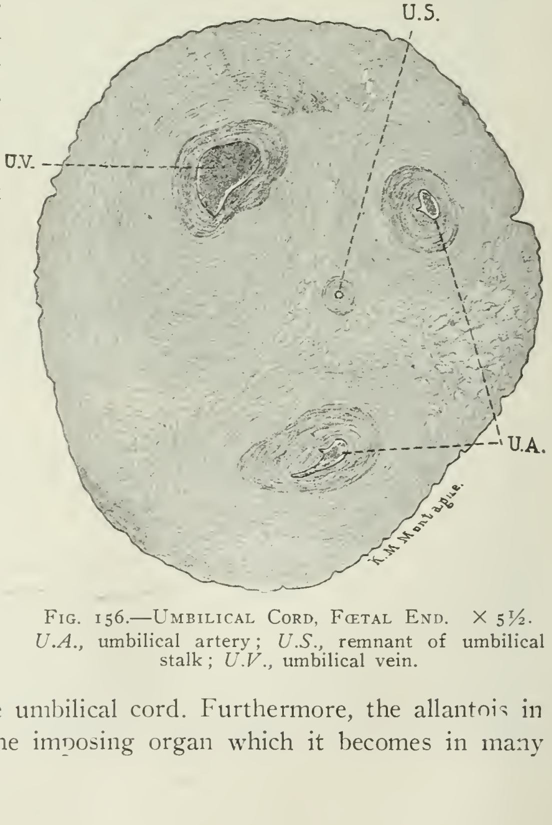


FIG. 156.—UMBILICAL CORD, FŒTAL END. × 5½. *U.A.*, umbilical artery; *U.S.*, remnant of umbilical stalk; *U.V.*, umbilical vein.

animals, but always remains a rudimentary structure, being represented by an entodermal tubule at the fœtal end of the abdominal pedicle.

Figure 158 represents a section through the abdominal pedicle of one of the early embryos studied by His, and clearly shows its analogy with the embryonic area. The great bulk of the structure is made up of mesodermic tissue in which the umbilical vessels and the allantois are embedded; its dorsal surface is covered by a single layer of ectoderm, showing at its middle a slight depression which represents a continuation of the medullary groove, while arching over it is the amnion. In its further development, the amnion, corresponding to the somatopleure, extends downward and inward, eventually inclosing a small portion of the cœlom in a way similar to that in which the abdominal walls are formed in the embryo itself (Fig. 159). In this cavity the stalk of the umbilical vesicle or yolk sac is included.

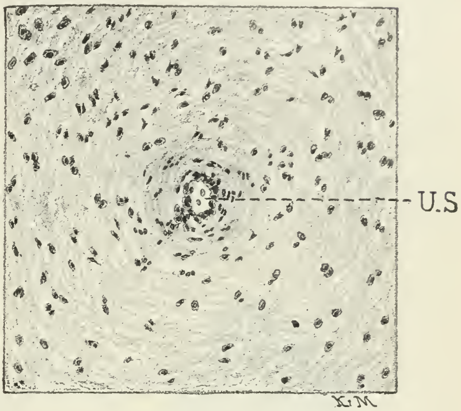


Fig. 157.—Section through Umbilical Cord, Showing Stalk of Umbilical Vesicle. × 110.

Figure 160 represents a thirty-day embryo described by His, and gives a good idea of the manner in which the stalk of the umbilical vesicle gradually becomes included within the cord.

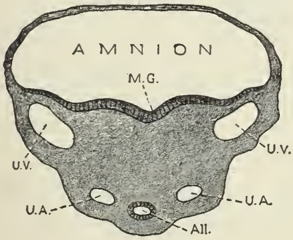


Fig. 158.—Section through Abdominal Pedicle of 2.25-Millimeter Embryo (His). × 50.

All., allantois; *M.G.*, medullary groove; *U.A.*, umbilical artery; *U.V.*, umbilical vein.

Umbilical Vesicle.—The yolk sac, or as it becomes later, the umbilical vesicle, is a very prominent organ at the beginning of pregnancy, and is present in all ova. In its earliest stages it represents the largest and most striking structure connected with the embryo, but as the latter develops, it becomes relatively smaller, and, as we have already shown, is taken up in great part to form the intestinal canal, so that after the formation of the abdominal walls it protrudes from the umbilicus into the cœlomic cavity as a rounded sac with a distinct stalk. As pregnancy advances the sac becomes smaller and its stalk longer.

The structure persists through pregnancy, and can frequently be found at full term, when it is represented by a flattened oval sac, 3 to 5 millimeters in diameter, which usually lies on the fœtal surface of the placenta, between the chorion and amnion, but occasionally in the membranes just beyond the placental margin. It is connected with the umbilical cord by a fine pedicle—the stalk, which, as has been already indicated, may be seen in sections through the cord at term. Schultze, in 1861, was able to demonstrate the umbilical vesicle in 146 out of 150 mature placentæ examined. Meyer has found that the vesicle may sometimes exceed the usual proportions, and measure as much as 10 to 15 millimeters in diameter.

The intra-abdominal portion of the duct of the umbilical vesicle, which extends from the umbilicus to the intestine, usually atrophies and disappears, but occasionally it remains patent, forming what is known as *Meckel's diverticulum,* which may play an important pathological part in later life.

In animals whose ova possess a large amount of yolk, the umbilical vesicle is the main source of nutrition for the embryo; but in women its significance is not so clear, since the proportion of yolk is exceedingly small. In some of the lower animals it affords a means of vascularizing the chorion, while in still others it takes part in the formation of an accessory placenta, in addition to the main one which is vascularized by vessels originating primarily in the chorionic membrane. It must, however, play an important part in the economy of the human embryo, as it develops a considerable circulation, and, as Selenka has shown, forms numerous crypts from its entodermal lining.

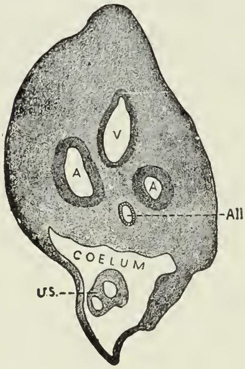


Fig. 159.—Section through Young Umbilical Cord (Minot).
A., artery; *All.*, allantois; *U.S.*, stalk of umbilical vesicle; *V.*, vein.

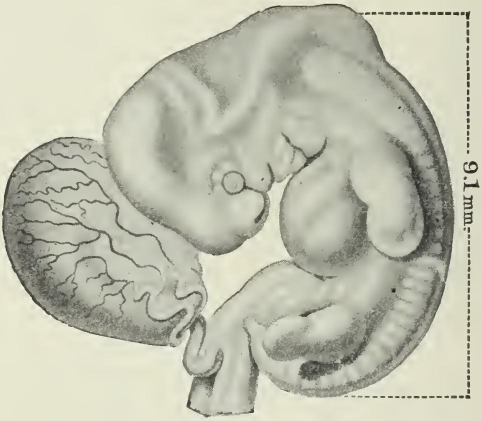


Fig. 160.—Stalk of Umbilical Vesicle Being Included in the Umbilical Cord (His).

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CHAPTER V

THE FŒTUS

The Fœtus in the Various Months of Pregnancy.—It is important that the physician be able to tell approximately the age of embryos and prematurely born children, and we shall therefore give a short description of the fœtus at its various periods of development.

The actual duration of pregnancy is not yet known, but ordinarily two hundred and eighty days, or ten lunar months, elapse between the commencement of the last menstrual flow and the onset of labor, though a considerable number of children are born shortly before or after the expiration of that period.

The following details concerning the development of the unborn child are taken in great part from His, who distinguished three periods in its evolution. Thus, during the first two weeks of pregnancy the product of conception is designated as the ovum; from the third to the fifth week—the period during which the various organs are developed and a definite form is assumed—it is known as the embryo; after the fifth week it becomes the fœtus.

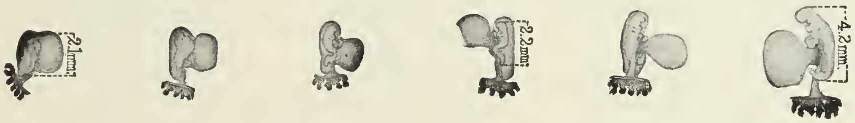


Fig. 161. Fig. 162. Fig. 163. Fig. 164. Fig. 165. Fig. 166.

Figs. 161-166.—Early Embryos Described by His.

First Two Weeks.—The earliest human ova with which we are acquainted (third week after fertilization) were enumerated in the preceding chapter. They are vesicular structures whose main feature is the chorionic vesicle, to one side of whose interior is attached the future embryo, so small a body that is component parts can be distinguished only with the aid of the microscope. In each instance the embryonic area is covered by a well-developed amnion, and the most imposing constituent of the embryo consists of the yolk sac.

Third Week.—The embryonal period begins with the third week, in the latter part of which can be detected the beginning formation of the medullary groove and canal, soon to be followed by the appearance of the head folds. At this stage of development the abdominal pedicle is seen coming off from the tail end of the embryo, and lying almost in the same axis with it. The embryo is concave on its dorsal surface, and is made up in great part of the yolk sac.

A little later the formation of the double heart may be noted; while the cerebral and optic vesicle, soon appear, as well as the visceral arches and clefts. The yolk sac becomes more and more constricted, and is connected with the ventral surface of the embryo by a broad pedicle. At the very end of the third week (about the twenty-first day) the limbs make their appearance as small buds upon the surface of the embryo. (Figs. 161-166).

Fourth Week.—This week is characterized by a great increase in the size of the embryo, which becomes markedly flexed upon its ventral surface, so that its head and tail ends come almost in contact. The rudiments of the eyes, ears, and nose now make their appearance, and the umbilical vesicle becomes still more pedunculated. At the end of the first lunar month, the "Anlagen" for all the organs have become differentiated and the embryo measures from 7.5 to 10 millimeters in length.

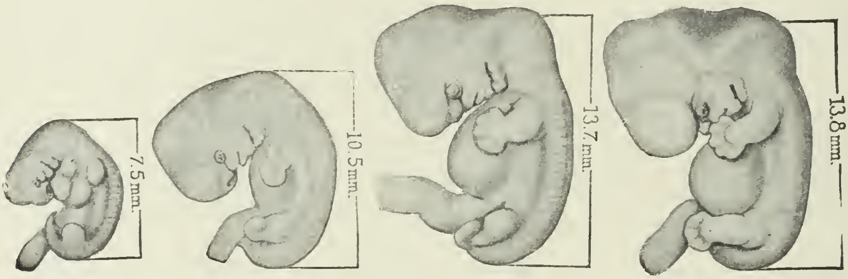


Fig. 167. Fig. 168. Fig. 169. Fig. 170.

Figs. 167-170.—Embryos from Fourth to Fifth Weeks (His). × 2.

Second Month.—In the first half of the second month the human embryo does not differ essentially in appearance from that of other mammals. It is still markedly bent on itself, and the visceral clefts and arches are the most prominent characteristics of its cephalic region, while the extremities are in a rudimentary condition. In the latter part of the month, owing to the development of the brain, the head becomes disproportionately large, and assumes a certain resemblance to that of a human being. At the same time the nose, mouth, and ears become relatively less prominent and the extremities more developed, so that it can be seen that each is made up of three portions. The external genitalia also make their appearance in the latter part of this month, and at its end the fœtus has attained a length of 2.5 centimeters.

Third Month.—At the end of this month the entire product of conception is about as large as a goose's egg, and the embryo measures from 7 to 9 centimeters in length. Centers of ossification have appeared in most of the bones; the fingers and toes become differentiated and are supplied with nails; the external genitalia are beginning to show definite signs of sex. A fœtus born at this time may make spontaneous movements if still within the amniotic sac or if immersed in warm saline solution.

Fourth Month.—By the end of the fourth month the fœtus is from 10 to 17 centimeters long, and weighs about 120 grams. Casual examination of the external genital organs will now definitely reveal the sex.

Fifth Month.—The fœtus varies from 18 to 27 centimeters in length and weighs about 280 grams. Its skin has become less transparent, a downy covering—lanugo—is seen over its entire body, while a certain amount of typical hair has made its appearance on the head.

Sixth Month.—At the end of the sixth month the fœtus varies from 28 to 34 centimeters in length, and weighs about 634 grams. The skin presents a characteristically wrinkled appearance, and fat begins to be deposited beneath it; the head is still comparatively quite large. A fœtus born at this period will attempt to breathe, but always perishes within a short time.

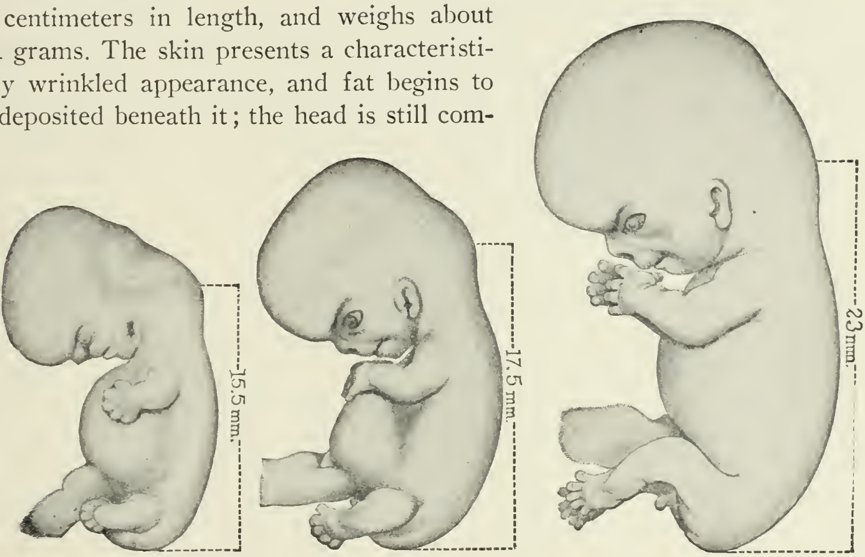


Fig. 171. Fig. 172. Fig. 173.

FIGS. 171-173.—EMBRYOS FROM SECOND MONTH (His). × 2.

Seventh Month.—The length during this month varies from 35 to 38 centimeters, and the fœtus attains a weight of over 1200 grams. The entire body is very thin, the skin is reddish and covered with vernix caseosa. The pupillary membrane has just disappeared from the eyes. A fœtus born at this period moves its limbs quite energetically and cries with a weak voice. As a rule, it cannot be raised, but occasionally expert care is rewarded by a successful outcome.

It is generally believed among the laity that a child born at the end of the seventh month has a better chance of living than when it comes into the world four weeks later. This idea is a remnant of the old Hippocratic doctrine and is altogether erroneous, as the more developed the child the greater are its chances for life.

Eighth Month.—At the end of the eighth month the fœtus has attained a length of 42.5 centimeters, and a weight of about 1900 grams. The surface of the skin is still red and wrinkled and the child resembles an old man in appearance. Children born at this period may live if properly cared for, though their chances are not very promising.

Ninth Month.—At the end of the ninth month the fœtus is 46 centimeters long, and weighs about 2500 grams. Owing to the deposition of subcutaneous fat, the body has become more rotund and the face has lost its previous wrinkled appearance. Children born during this month have a very good chance of life if properly cared for.

Tenth Month.—Full term is reached at the end of this month. The fœtus is now fully developed, and presents the appearances which we shall consider in detail when the new-born child is described.

The fœtus grows relatively much faster in the early than in the later months of pregnancy. According to Jackson, the weight of the mature ovum is 0.000004 gram, which increases to 0.04 gram by the end of the first month after fertilization—an increase of 9999 times, or practically one million per cent. In the second and third months the rate of increase has become reduced to 74 and 11 fold respectively, and gradually falls to 0.3 fold in the last month. Even this comparatively slow rate is not maintained after birth, for if it were the child would weigh about 160 pounds by the end of the first year.

Owing to inequalities in the length of the legs, and the difficulty of maintaining them in extension during mensuration, the determination of the sitting height (crown-rump) is more accurate than that of the standing height. According to Streeter, the average sitting height and weight of the fœtus at the end of the various lunar months, as determined from 704 specimens, are as follows:

LUNAR MONTH	SITTING HEIGHT Centimeters	WEIGHT Grams
2nd	0.23	1.1
3rd	6.1	14.2
4th	11.6	108.0
5th	16.4	316.0
6th	20.8	630.0
7th	24.7	1045.0
8th	28.3	1680.0
9th	32.1	2478.0
10th	36.2	3405.0

Such figures possess only an approximate value, and generally speaking the length affords a more accurate criterion of the age of a fœtus than its weight. Haase has suggested that for clinical purposes the length of the embryo in centimeters may be approximated during the first five months by squaring the number of the month to which the pregnancy has advanced; in the second half of pregnancy, by multiplying the month by 5, as is shown in the following table:

At the end of the first month	1×1,	1 centimeter
“ “ “ second month	2×2,	4 centimeters
“ “ “ third month	3×3,	9 “
“ “ “ fourth month	4×4,	16 “
“ “ “ fifth month	5×5,	25 “
“ “ “ sixth month	6×5,	30 “
“ “ “ seventh month	7×5,	35 “
“ “ “ eighth month	8×5,	40 “
“ “ “ ninth month	9×5,	45 “
“ “ “ tenth month	10×5,	50 “

The Child at Full Term.—The average child at full term is 50 centimeters or 20 inches long (36 centimeters or 14 inches sitting height), and weighs 3250 grams or 7¼ pounds. The skin is smooth and polished in appearance, and shows no lanugo, except occasionally about the shoulders. Over the entire surface is spread a whitish, greasy material, the *vernix caseosa,* which is a mixture of epithelial cells, lanugo hairs, and the secretion of the sebaceous glands. The head is usually covered by darkish hairs 2 to 3 centimeters in length, and the cartilages of the nose and ears are well developed. The fingers and toes possess well-developed nails, which project beyond their tips. In male children the testicles are usually found within the scrotum; in girls the labia majora are well developed and are in contact with one another, and usually conceal the rest of the genitalia. The bones of the head are well ossified, and are in close contact at the various sutures. The eyes possess a uniformly slate color, so that it is impossible to predict their final tone.

Blécard, in 1828, described a center of ossification, 0.5 centimeter in diameter, in the lower epiphysis of the femur. He considered it a diagnostic sign of maturity, but Ballantyne and Browne found it of this size in only one-third of one hundred full-term children. Adair and Scammon have likewise studied the ossification centers at birth by means of röntgen rays. They found the proximal epiphyseal center of the tibia present in 81 per cent of their cases, and usually two centers in the tarsus but none in the carpus. On the other hand, the tarsus sometimes contained a third center—that of the cuboid bone, while in about one-sixth of their infants two centers were noted in the carpus. Such observations invalidate the conclusions of Hahn, according to which absence of the proximal epiphyseal center of the tibia always indicates prematurity.

My own experience is that while x-ray examination of the ossification centers gives important information, it cannot always be relied upon to determine whether the child is premature, mature or postmature. For example, Ballantyne and Browne pointed out that a third tarsal center was never observed in the premature child, was present in 7 out of 22 full-term children, and yet was lacking in many which were clearly postmature. Holzbach holds that the most valuable sign of maturity is to be found in the relation between the fronto-occipital circumference of the head and that of the shoulder, as in only 1 out of 3 premature children which he examined did the latter equal the former in size. No one of these conditions affords indisputable proof of the maturity of a child, but when the majority of them are present the evidence becomes fairly convincing.

Negro babies at birth differ somewhat in appearance from white children, but not so much so as one might expect. Their skin presents a dusky, bluish-red hue, but does not at all suggest the darker color which it will assume in the course of a few weeks. Where there is a considerable admixture of white blood, the dusky hue may be entirely absent, and the only certain evidence of Negro ancestry will be found in an increased pigmentation about the external genitalia, and at the matrix of the nails.

Weight of the Newborn.—The average infant at birth weighs about 3250 grams (7¼ pounds), boys being usually 100 grams (3 ounces) heavier than girls. Marked variations are frequently observed, which are dependent upon the race and size of the parents, the number of children which the mother has borne, her mode of life, and her nutrition and general condition during the later months of pregnancy. In 707 full-term white children born at the Johns Hopkins Hospital, T. F. Riggs found that the average length was 49.64 centimeters, and the average weight 3316.9 grams (7.32 pounds), the smallest child weighing 2180 grams (4 pounds 12 ounces) and the largest 4553 grams (10 pounds).

Colored children weigh considerably less, a fact which, in large cities at least, is indicative of the physical degeneration which characterizes the race. Four hundred and seventy such children at full term studied by Riggs averaged 48.75 centimeters in length and 3104.8 grams in weight, a difference of 211 grams (7 ounces) in favor of the white race.

Perfectly healthy full-term children may vary from 2500 to 5000 grams (5.5 to 11 pounds) in weight. It is, however, customary to designate them as excessive in size whenever 4500 grams (10 pounds) is exceeded; yet actual dystocia is rarely encountered unless the weight exceeds 5000 grams, provided, of course, that the pelvis and fœtal presentation are normal. In the many thousand children delivered under my supervision heavier ones are rarely encountered, although in one instance an immense child weighed 6470 grams (14¼ pounds) and measured 62.5 centimeters in length.

It is not uncommon to hear of children much heavier than 5000 grams and sometimes almost fabulous weights are reported. Most of these must be regarded as apocryphal, and careful inquiry will usually show that the weight has been only roughly estimated by lifting the child in the hand, and was not based upon accurate determination. Winckel found only 5 children that weighed over 5000 grams in 30,500 deliveries, Starcke 16 in 34,000 deliveries in Leopold's clinic, and Varnier stated that in seven years, at the Baudelocque Clinic in Paris, only 6 children exceeded that weight. Moreover, it is probable in many instances that the excessive weight should be attributed to the fact that the pregnancy had persisted several weeks beyond the usual term—in other words, that the children were postmature.

Dubois, in 1897, collected from the literature 28 cases in which the child weighed 5600 grams (12 pounds) or more at birth, and stated that the heaviest children on record were reported by Ortega, Rachel and Neumer, and Beech, and weighed respectively 11,300, 11,250, and 10,750 grams. In spite of these exceptional cases, one should be extremely skeptical in accepting reports concerning phenomenally heavy children, unless convinced that the reporter is a truthful person and has weighed the child upon an accurate balance.

On the other hand, healthy full-term children frequently weigh less than 3250 grams, and sometimes as little as 2300 grams (5 pounds); although, when the weight falls below 2500 grams, the child should be considered as premature unless its length exceeds 45 centimeters. Any weight below this limit, in the case of an infant born at term, should always lead one to suspect some disease on the part of the mother or fœtus, as nephritis or syphilis.

Generally speaking, premature children weighing less than 1500 grams and measuring less than 35 centimeters in length have practically no chance of life, though occasionally they may do well, and exceptionally we succeed in raising children which weigh less than 1200 grams. H. A. Powell, of Cleveland, informed me that he had successfully raised an infant which weighed 750 grams at birth.

The size of the fœtus usually increases with the age of the mother up to the thirtieth year, if pregnancies have not followed in too rapid succession. The size is also dependent, to a considerable extent, upon that of the parents, especially the father; and in many instances the child's head closely resembles that of the latter in shape.

The social condition of the mother and the comforts by which she is surrounded also exert a considerable influence upon the child's weight, heavier children being more common in the upper walks of life. Thus, on looking over the records of my private patients, I found that healthy full-term children averaged 3795 grams in weight, as compared with 3316.9 and 3104.8 grams for the white and colored children in the clinic—a difference of 478 and 690 grams, respectively.

Pinard and Bachimont, from a study of 4445 cases observed in the Baudelocque Clinic, arrived at somewhat similar conclusions. They found that the children of women who had lived in the hospital for three months prior to confinement averaged 500 grams heavier than those of patients who had entered it just before or during labor. They consider that this difference is due to the better nourishment of the former class of patients, as well as to the avoidance of premature labor incident to hard work. T. F. Riggs made similar observations in my service at the Johns Hopkins Hospital, but found that there was a greater increase in weight in the colored than in the white children. He was inclined to attribute the difference to the fact that the hospital fare was no better than that which the white women received in their homes, but was superior to that to which the average colored woman is accustomed.

It is generally believed that the comparatively difficult labors of the women of the upper classes are due to the enervating influences of civilization and luxury, while the easy labors of Negroes are considered as manifestations of a closer approach to Nature. Such conclusions are not justified by my experience, as the physical degeneration of colored women living in large cities is proven by the fact that in them the incidence of contracted pelvis is four or five times greater than in white women. Were this not counterbalanced by the lesser weight of the black children, and particularly by the smaller size and greater compressibility of their heads, labor would be a disastrous function, and would comparatively soon lead to a solution of the race problem. If the Negro children were as large and had as hard heads as in the upper classes, I should be obliged to perform cesarean section several times more frequently than I actually do. Accordingly, it appears permissible to attribute the more difficult labors in the upper classes to the larger size of their children, resulting from abundant nutrition and a life of ease, rather than to the enervating influences of civilization.

Such deductions are somewhat invalidated by the experience with the babies born in Germany during the World War. Owing to the hunger blockade the nutrition of the mothers suffered severely, yet the average weight of the babies was but slightly changed. This observation apparently indicates that, to some extent at least, the intra-uterine child lives as a parasite upon its mother, so that if sufficient nutriment is not supplied in the usual way, it is able to abstract the needed materials from her tissues.

The Head of the Child.—From an obstetrical point of view the head of the child is its most important part, as the essential feature of labor is a process of adaptation between it and the various portions of the birth canal through which it passes. An accurate knowledge of its characteristics and size is therefore of capital importance.

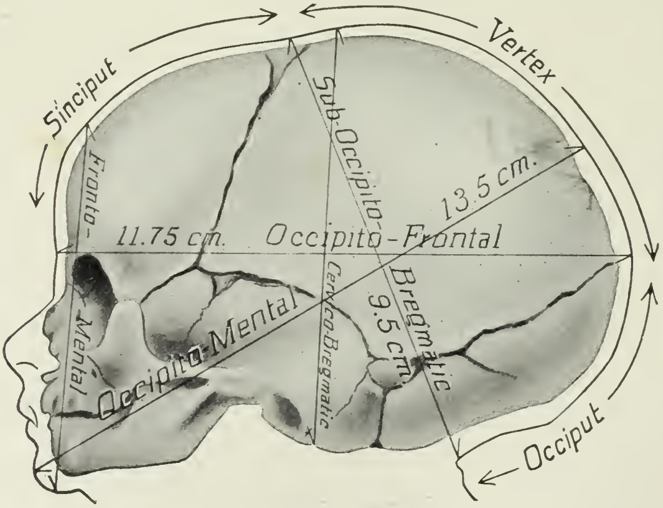


FIG. 174.—CHILD'S HEAD AT TERM. × ⅔. (American Textbook.)

Only a comparatively small part of the head of the child at term is represented by the face, the rest being composed of the firm, hard skull, which is made up of two frontal, two parietal, two temporal bones, the upper portion of the occipital, and the wings of the sphenoid. These bony portions are not firmly united together, but are separated from one another by spaces filled with membrane—the *sutures.* Of these the most important are the *frontal,* between the two frontal bones; the *sagittal,* between the two parietal bones; the *coronal,* between the frontal and parietal bones; and the *lambdoid* suture, between the posterior margins of the parietal bones and the upper margin of the occipital bone. All these sutures can be felt during labor; whereas the *temporal* suture, which is situated on either side between the inferior margin of the parietal and the upper margin of the temporal bones, is covered by soft parts and cannot be felt on the living child.

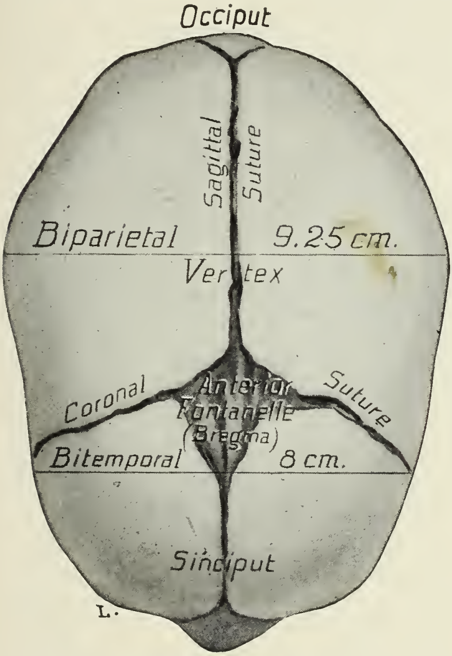


Fig. 175.—Child's Head at Term. × ⅔. (American Textbook.)

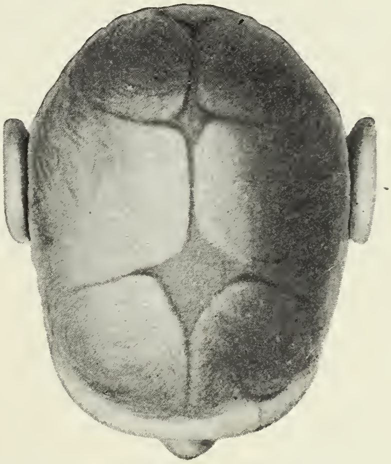


Fig. 176.—Head at Term, Showing Small, Sagittal, and Large Fontanels. × ½.

Where several sutures meet together an irregular space is formed, which is closed by a membrane and designated as a *fontanel.* Four such structures are usually distinguished: the greater and lesser, and the two temporal fontanels. The *greater* or *anterior fontanel* is a lozenge-shaped space situated at the junction of the sagittal and the coronal sutures. The *lesser* or *posterior fontanel* is represented by a small triangular area at the intersection of the sagittal and lambdoid sutures. The *temporal* or *gasserian fontanels* are situated at the junction of the lambdoid and temporal sutures. The first two are readily felt during labor, and their recognition gives important information concerning the presentation and position of the child; the temporal fontanels, however, have no diagnostic significance.

Arnold Lea directed attention to the occasional presence of what he designated as the *sagittal fontanel,* which is a lozenge-shaped space found in the sagittal suture at a point about half-way between the greater and lesser fontanels. He considers that it results from faulty ossification of the parietal bones, and states that it occurred in 4.4 per cent of 500 fœtal skulls which he examined. Adair and Scammon state that it occurs in a rudimentary form in about 30 per cent of all newly born children, but attains an area of one square centimeter or more in 3.27 per cent. Whenever it is large enough to be confused with the large fontanel it may give rise to serious error in diagnosis.

To aid us in forming definite ideas concerning the shape and size of the fœtal head, it is customary to measure certain *diameters* and *circumferences.* The diameters most frequently used are: (1) the fronto-occipital, which follows a line extending from the root of the nose to the most prominent portion of the occipital bone; (2) the biparietal, which represents the greatest transverse diameter of the head, and extends from one parietal boss to the other; (3) the bitemporal, which represents the greatest distance between the two temporal sutures; (4) the mento-occipital, from the chin to the most prominent portion of the occiput; and (5) the suboccipitobregmatic, which follows a line drawn from the middle of the large fontanel to the under surface of the occipital bone, just where it joins the neck. For convenience the various diameters are frequently designated by initials, which, with their several average measurements, are given in the following table:

	Initials	Average Length, Centimeters	Riggs' Figures, Centimeters	
			White	Black
Fronto-occipital	F. O.	11.75	11.71	11.26
Biparietal	B. P.	9.25	9.25	9.05
Bitemporal	B. T.	8.00	8.00	7.81
Mento-occipital	M. O.	13.5	13.33	13.31
Suboccipitobregmatic	S. O. B.	9.5	9.70	9.29

The greatest *circumference of the head,* which corresponds to the plane of the fronto-occipital diameter, is 34.5 centimeters, while the least circumference corresponding to the plane of the suboccipitobregmatic diameter, is 32 centimeters. The figures just given are based upon the average measurements of a large number of heads just after birth, individual variations being frequently encountered. As a rule, boys have somewhat larger heads than girls, and the children of multiparæ than those of primiparæ. As indicated in the table, Riggs's figures show that all of the diameters are shorter in Negro children; but such measurements give no idea of the greater softness and compressibility of their heads. According to Calkins the various measurements of the head bear a constant relation to the standing height of the child. Consequently, he states that measurements of the head, when plotted as ordinates against the standing height as abscissæ, result in a straight line curve. This being the case, the relationship between any two dimensions can be expressed by the straight line empirical formula: $y = a x \pm b$; x and y being body dimensions and a and b constants.

A certain amount of motility exists at the sutures between the various bones composing the skull. This may vary within relatively wide limits in different individuals, so that heads which afford the same diameters on actual measurement frequently differ markedly in the obstacle which they offer to labor; as the bones of one may be soft, compressible, and readily displaced, while those of another are firmly and densely ossified and admit of but little motility, the former being readily molded to the pelvic canal, while the latter are incapable of reduction in size.

Physiology of the Fœtus.—Our knowledge concerning the physiology of the fœtus has been markedly enriched during recent years; nevertheless, when compared with that of the adult, it offers many points concerning which we are but slightly informed or profoundly ignorant.

Nutrition of the Fœtus.—Owing to the small amount of yolk contained in the human ovum, the growth of the fœtus is almost entirely dependent upon the amount of nutritive material which it obtains from its mother.

During the first few months of pregnancy, as Fehling first pointed out, the embryo consists almost entirely of water, and it is during this period that it grows most rapidly. In the later months of pregnancy, when more solids are being added, the increase in size becomes gradually slower. Fehling's conclusions were confirmed by Michel, and Schmitz; the former analyzed the fœtus at various periods with the results noted in the following table, which indicates that, as the fœtus increases in age, it contains relatively less water and a markedly increased quantity of albuminoid materials, salt, and fats. The latter showed that the total quantity of calcium contained in the fœtus, estimated as CaO, increases from 0.045 gram at the third month to 28 grams at term, while the daily increment increases from 0.0015 to 0.399 gram at corresponding periods.

	Water, Per Cent	Albuminoids, Per Cent	Salts, Per Cent	Fats, Per Cent
At 2½ months	93.82	4.49	Trace	Trace
3rd to 4th month	89.95	7.05	1.729	0.0379
7th month	84.75	10.04	2.487	1.823
At term	69.16	13.96	3.373	11.75

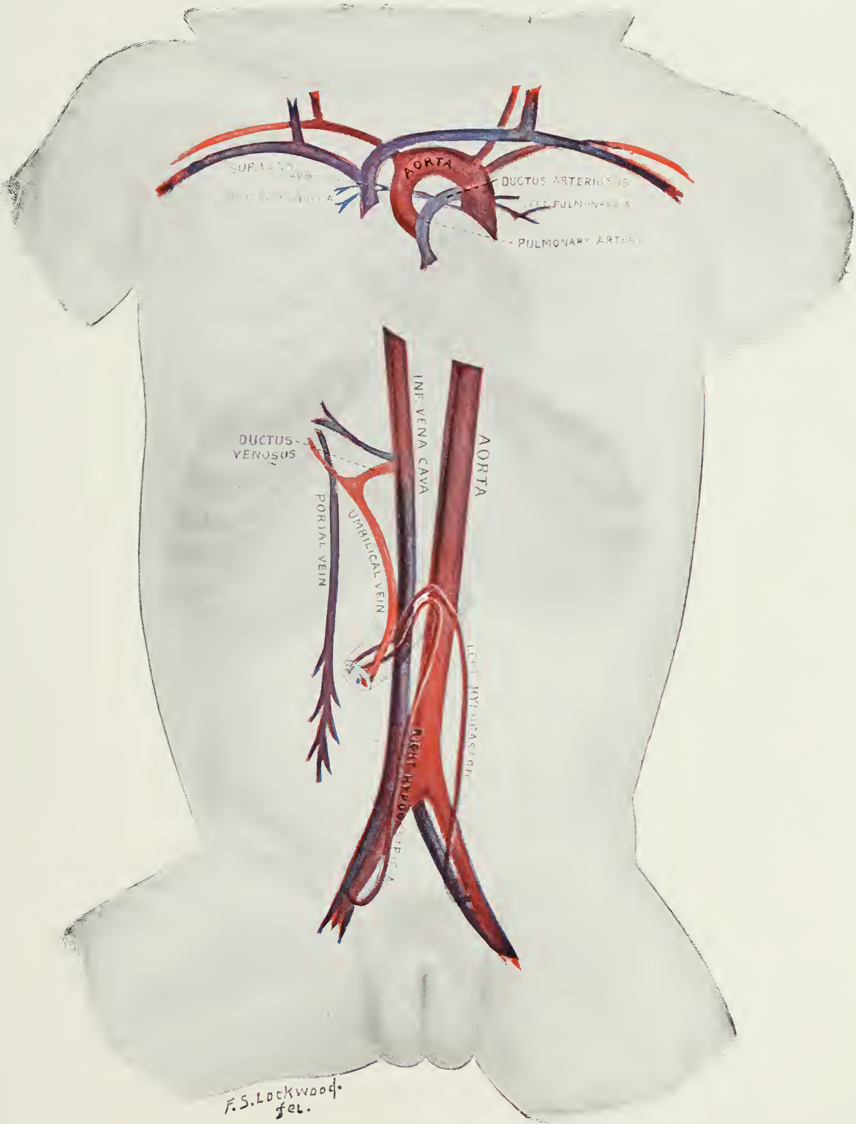
For the first few days after implantation, the nutrition of the ovum must be derived from the serum which accompanies the edematous condition of the decidua. Furthermore, the surrounding maternal tissue which has undergone necrosis as the result of the digestive action of the trophoblast, as well as the greatly augmented glandular secretion which characterizes this period, probably serves as a pabulum, to which is added the glycogen, which Driessen has shown accumulates in the endometrium during the period of premenstrual swelling. Within the next week intervillous spaces, which are filled with maternal blood, begin to develop between the trophoblast and deciduo. As the chorionic villi at this period are devoid of vessels, the only way in which nutritive material, which has been taken up by the trophoblast from the maternal blood, can be transmitted to the embryo is by means of direct osmosis.

In the third week of pregnancy the omphalomesenteric vessels make their appearance upon the surface of the umbilical vesicle, and convey to the embryo whatever nutritive materials the latter may contain. During the fourth week branches of the umbilical vessels appear in the chorionic villi, and from that time on make possible the direct transmission of nutritive material from the material to the fœtal blood.

The Fœtal Circulation.—Owing to the fact that the lungs do not function, and that the materials needed for the nutrition of the fœtus are brought to it from the placenta by the umbilical vein, the fœtal circulation differs materially from that of the adult (Plate VIII). The blood is purified and laden with nutritive material in the placenta, and is then carried to the fœtus through the umbilical vein, which, after penetrating the abdominal wall, divides into two branches. Of these the smaller unites with the portal vein, the blood from which circulates through the liver and then gains access to the inferior vena cava through the hepatic vein. The other larger branch, which is designated as the ductus venosus, empties directly into the vena cava. The contents of the vena cava above the hepatic vein, therefore, consist of a mixture of arterial blood from the placenta and venous blood returning from the lower extremities of the fœtus. Thus far all investigators agree, but there is still considerable divergence of opinion as to the course the blood takes after entering the heart. It is generally taught that upon entering the right auricle it is deflected by the intervention of the eustachian valve in such a manner as to pass through the foramen ovale into the left auricle, whence it passes into the left ventricle, which forces it into the aorta. On the other hand, the blood returning from the head and upper extremities by way of the superior vena cava is poured into the right auricle, and, crossing the current from the inferior vena cava, passes into the right ventricle, whence it is forced into the pulmonary arteries. But so long as the lungs do not function, only a small portion of this blood gains access to them, the greater part of it passing through the ductus arteriosus to the arch of the aorta, and being then carried to the rest of the body of the embryo.

According to this view, the blood from the inferior and superior vena cava does not mix in the right auricle, but the two currents cross each other in such a way that the purer blood from the inferior cava passes directly to the left side of the heart through the foramen ovale, and is supplied in great part to the head and neck; while the less pure blood from the superior cava passes

PLATE VIII.


SUP. VENA CAVA
AORTA
DUCTUS ARTERIOSUS
LEFT PULMONARY A
PULMONARY ARTERY
DUCTUS VENOSUS
PORTAL VEIN
UMBILICAL VEIN
INF. VENA CAVA
AORTA
LEFT HYPOGASTRIC
RIGHT HYPOGASTRIC A
F.S. Lockwood fec.

FŒTAL CIRCULATION.

through the right auriculoventricular opening and is forced by the right ventricle into the pulmonary arteries and the ductus arteriosus.

Pohlman (1909) states that this view is incorrect, as it is physically impossible for the two currents to cross each other without mixing. Accordingly, he believes that the two currents mix in the right auricle while enough of the mixed blood passes into the left auricle through the foramen ovale to make up for the deficient return through the pulmonary veins. Ziegenspeck likewise believes that the blood in the two auricles is identical in composition, but that the result is accomplished in a different manner.

In any event, the blood which has gained access to the aorta directly from the left, as well as indirectly from the right, ventricle through the ductus arteriosus is propelled down the aorta and given off to the various organs according to their needs; but the bulk of it enters the internal iliac and hypogastric arteries—the latter after passing the umbilicus being designated as the umbilical arteries—and through them gains access to the placenta.

From the foregoing description it is apparent that the blood circulating in the fœtus is at no time strictly arterial or strictly venous, but that the content of the inferior vena cava is purer than that of the aorta.

The distinctive features of the fœtal circulation are connected with the ductus venosus and arteriosus, the foramen ovale, the hypogastric arteries, and the umbilical cord. After birth these structures undergo marked changes. As soon as the child is born and begins to breathe, the pulmonary circulation becomes established. As a result, a much greater quantity of blood is pumped by the right ventricle into the pulmonary arteries, while a lessened amount passes through the ductus arteriosus. Moreover, as soon as the circulation in the cord is abolished, the umbilical vein becomes functionless, and a diminished quantity of blood is returned to the right auricle by the inferior vena cava. This change leads to a diminution in the tension in the right auricle, while that in the left side of the heart is increased, bringing about the closure of the valvelike foramen ovale.

As the circulation through the umbilical arteries ceases almost immediately after the pulmonary circulation is established, the function of the hypogastric arteries is in abeyance, and their distal ends rapidly undergo atrophy and obliteration, which is usually complete three or four days after birth. The ductus venosus and umbilical veins also become occluded during the first week, whereas the closure of the ductus arteriosus is more gradual, and frequently its opening does not become impervious until several weeks after birth. Permanent closure of the foramen ovale does not occur for some time, and not rarely months elapse before it is completed. Occasionally it remains patent, and circulatory disturbances of greater or less gravity result from its persistence.

Transmission of Substances through the Placenta.—As was shown when considering the structure of the placenta, there is no direct communication between the vessels of the chorionic villi and the intervillous blood spaces. In the first half of pregnancy fœtal and maternal blood are separated from each other by the syncytium, Langhans' layer of cells, a thicker or thinner leaflet of the stroma of the villus, and the walls of the fœtal capillaries, while in the second half Langhans' layer gradually disappears.

The independence of the two circulations is readily demonstrated during the first months of pregnancy by comparing the contents of the fœtal vessels with that of the intervillous spaces. In the former large numbers of nucleated red corpuscles are found, which are never present in the latter. In order that substances may pass from the mother to the fœtus, or in the reverse direction, it is necessary for them to traverse the layers of tissue which we have just mentioned. It would appear that gases and substances in solution generally pass by osmosis directly from the maternal to the fœtal blood and vice versa. It should not, however, be assumed that the placenta acts merely as a dialyzing membrane, as colloids and formed substances must undergo certain changes in the chorionic epithelium before they can be transmitted. Moreover, the fact that the concentration of certain electrolytes differs in the two bloods indicates that even in their case other factors than osmosis must be involved.

The transmission of gaseous substances has been definitely demonstrated both by clinical observation and experimental work. Comparison of the blood in the umbilical vein and arteries, respectively, shows that the former is lighter in color, indicating that it is richer in oxygen than the latter. This fact has also been demonstrated experimentally by Zweifel, who showed that the blood in the umbilical vein, when examined by means of the spectroscope, contained oxyhemoglobin. Again, Cohnstein and Zuntz have demonstrated in sheep that the blood of the umbilical vein is richer in oxygen and poorer in carbon dioxide than that contained in the umbilical arteries. Zweifel has also shown that chloroform administered to the mother is rapidly transmitted to the fœtus, and Nicloux has made similar observations with ether.

The increase in the size of the fœtus affords conclusive evidence of an interchange of nutrition and other material between it and the mother, and this has been demonstrated experimentally for many substances in solution. The first work of this character we owe to Mayer who, in 1817, proved the passage of cyanide of potassium. Since then similar demonstrations have been made for many substances, and scarcely a year elapses without some increase in our knowledge along such lines. Furthermore, the demonstration by Krönig and Füth, that the freezing points of both maternal and fœtal blood are identical indicates that both possess the same osmotic pressure, and consequently that osmosis can occur equally readily in either direction unless some obstacle to it is afforded by the membrane which separates the two bloods. Nicloux summarized our knowledge upon the subject up to 1909, and among other substances mentioned iodide and bromide of potassium, phosphorus, the salts of mercury, copper, arsenic and lead, carbolic acid, salicylate of sodium, quinine, morphia, atropine, urea and alcohol.

Slemons and his associates, together with Plass, and Hunter and Campbell have clearly shown that urea, uric acid, creatine and creatinine are present in the same concentration in the maternal and fœtal bloods and therefore must pass from one to the other by simple osmosis. On the other hand, they found the amino-acids and nonprotein-nitrogen higher in the fœtal than in the maternal blood, while the reverse held good for glucose. They assume that all of these substances are transmitted by osmosis, but that the higher content of amino-acids and nonprotein nitrogen in the fœtal blood indicates that they are in some way "fixed" by it; while the higher glucose content of the maternal blood represents a mechanism to insure a constant osmotic flow of this important substance to the fœtus.

Plass in this clinic studied the relations of calcium and phosphoric acid, and found that the former is more abundant in the fœtal than in the maternal blood, which is what one would expect when the need for calcium in the formation of the fœtal skeleton is borne in mind. On the other hand, he found the total phosphorus content much greater in the maternal blood; while more minute analyses showed how readily incorrect conclusions may be drawn unless all of the factors concerned are critically considered. For example, when he came to differentiate between the lipoid, organic and inorganic fractions, it was found that the lipoid phosphorus did not pass to the fœtus at all, while the organic and inorganic phosphorus did, and were present in considerably larger quantities in the fœtal blood.

It appears that lipoids as such do not pass the placental filter at all, and Slemons and Stander hold that the fat required by the fœtus is built up from glucose. They base their conclusion upon the fact that the fat content of the maternal blood becomes definitely increased during pregnancy and always exceeds that of the fœtal blood, yet no fixed ratio can be established between the two. For these reasons, they believe that the increased lipoid content of the maternal blood should be regarded as a preparation for lactation, but that it plays no part in the nutrition of the fœtus *in utero*. On the other hand, Bonnet, Hofbauer, Goldmann, and others believe that fat is taken up by the chorionic epithelium, and after undergoing radical change is eventually passed on to the fœtal circulation. Whether this occurs in man is uncertain, but Hofbauer clearly showed that it occurs in experimental animals, as was evidenced by the fact that, when pregnant animals were fed with fat stained with Sudan red, characteristically stained fat could be demonstrated in the maternal blood in the intervillous spaces, but only unstained fat in the syncytium and stroma of the villi.

It is generally believed that the passage of formed substances does not occur, unless the material has first undergone marked changes under the influence of the chorionic epithelium, or when the placenta presents lesions. Reference has already been made to the mechanism by which fat is taken up from the maternal blood, and similar processes are concerned in the utilization of iron and albuminous substances. Iron is taken up by the trophoblast in the form of hemoglobin, derived from hemolized maternal blood, and by appropriate biochemical technic can be demonstrated in the epithelium and stroma of the villa on its way to the fœtal vessels. Albuminous substances are broken down into simpler compounds, which are recombined after passing into the fœtal blood. It is as yet uncertain whether they are resolved into their constituent amino-acids or into intermediate substances, although Hofbauer could only demonstrate the presence of albumoses.

Our knowledge upon the subject was well summarized by Hofbauer, in 1909, still further advanced by Goldmann's researches upon "vital staining," and again brought together by Kehrer. The work of Wislocki, and Schmidzu has definitely shown that colloidal dyestuffs are unable to pass the placental filter unless their particles are extraordinarily minute.

Upon summarizing these observations, it is apparent that the various excrementitious substances and glucose follow the laws of simple osmosis, that fat is not transmitted at all, and that the amino-acids, calcium, and inorganic and organic phosphorus are more abundant on the fœtal side, so that if they are transmitted by osmosis some mechanism must exist for their fixation in the fœtal blood. Otherwise, it must be assumed that the chorionic epithelium must exert some selective activity, such as Cunningham has demonstrated in the cat, in which sodium ferrocyanide readily passes into the fœtal blood while iron ammonium citrate does not. Moreover, it appears that the passage of organic substances through the placenta is accomplished by processes analogous to those occurring in the intestines, and that the syncytium is not only able to change many substances, but also has definite powers of selection. Plausibility is lent to such a view by the discovery by Ascoli, Bergell and Falk and others that the chorionic villi, and particularly their epithelium, are rich in ferments. Maeda, in 1923, demonstrated the presence of large amounts of diastase, as well as of trypsin and erepsin, various fat splitting ferments, histozyme (which splits hippuric acid into glycocol and benzoic acid), and a salicylic acid splitting ferment; while Wehefritz and Gierhake, in 1928, demonstrated the presence of considerable quantities of arginase.

Although Claude Bernard, as early as 1859, demonstrated the presence of glycogen in the placenta, its significance has only recently been appreciated. The investigations of Driessen, Jaretsky, and others have shown that before each menstrual period it is deposited in considerable quantities in the endometrium apparently in anticipation of the nutrition of the ovum. Moreover, in the first half of pregnancy, large quantities of glycogen are found not only in the decidua but also in the syncytium, cell nodes, and trophoblastic islands of the placenta, so that these structures in all probability store glycogen and give it up to the fœtus whenever sugar is needed.

Great caution must be exercised in applying to man, or even to other animals, conclusions drawn from observations or experiments upon animals of another species, on account of the remarkable differences in the structure of the placenta in even closely related species. It should always be remembered that in the semiplacentæ of swine, cattle and sheep there is no possibility of the transfer of materials from the maternal to the fœtal blood by means of osmosis, but that the nutrition of the fœtus is effected by direct absorption by the chorionic epithelium of the so-called uterine milk—the secretion of the uterine glands; moreover in the dog and cat the conditions are by no means analogous to those obtaining in man, as in them it is not unusual to observe maternal erythrocytes in the process of digestion within the bodies of the high columnar, chorionic epithelial cells, those nearest the surface presenting a normal appearance, while those at the basal portion of the cells have undergone almost complete dissolution.

The work of Polano, Wegelius, and others has shown that many toxins and antitoxins are transmitted through the placenta—notably those of diphtheria, tetanus, colon and typhoid. Ratner and his colleagues have demonstrated in guinea-pigs the transmission of protein hypersensitiveness from mother to offspring, and assume that it applies to man. They have also collected the voluminous literature upon the entire subject of placental permeability.

The possibility of securing from placental extract a sex-hormone reaction similar to folliculin, raises the interesting question as to whether it arises in situ or is brought to the placenta by means of the maternal blood. That various substances arising in the fœtus pass through the placental filter is generally assumed, and the method of determining the sex of the unborn child by the ability of the maternal serum to break down testicular tissue, as described by Lüttge and Merz, is an illustration in point. That such transmission is selective is indicated by the fact that Snyder and Hoskins have shown that adrenalin, insulin and pituitrin injected into the embryo *in utero* do not appear in the maternal blood.

The question as to whether the placenta acts as an efficient filter against bacteria has given rise to a great deal of discussion, but at present the consensus of opinion is that such transmission occurs but rarely, and then only in connection with some distinct lesion of the organ, or in the presence of an unusually virulent infection. Our knowledge along such lines was well summarized by Braun and Hofmeier, who reviewed the extensive literature up to 1928. The occurrence of intra-uterine smallpox was urged by John Hunter as proof in support of the affirmative view. Formerly it was not infrequent for mothers who suffered from smallpox during pregnancy to give birth to children bearing marks of the disease, and one of the most celebrated cases of this character was that of Mauriceau, the well-known obstetrician of the seventeenth century, who was born pock-marked. The significance of this occurrence, however, is by no means clear, inasmuch as we are not as yet acquainted with the *materies morbi* concerned.

Lubarsch has shown that the organisms of anthrax, pneumonia, typhoid fever, relapsing fever, and the various infections due to pyogenic organisms may be transmitted now and again, but regards such an occurrence as exceptional. This is particularly well shown in tuberculosis, as out of the large number of tuberculous women who are delivered every year, Whitman, and Green, in 1922, were able to collect only 122 who had given birth to children or placentæ which gave evidence of the disease. Likewise, in none of the placentæ from tuberculous women which I have examined have I been able to find lesions in the fœtal portion, even when the decidua was affected by the disease.

In typhoid fever, on the other hand, it would appear that the transmission of organisms occurs frequently. Speier, in 1897, found the specific bacilli in the organs of a fœtus whose mother was suffering with typhoid fever, and F. W. Lynch, in 1902, reported a case of the same character from my service. Since then we have repeatedly made similar observations, and Hicks and French noted such a transmission in 10 out of 30 cases, so that it is now generally recognized as a frequent concomitant of the disease.

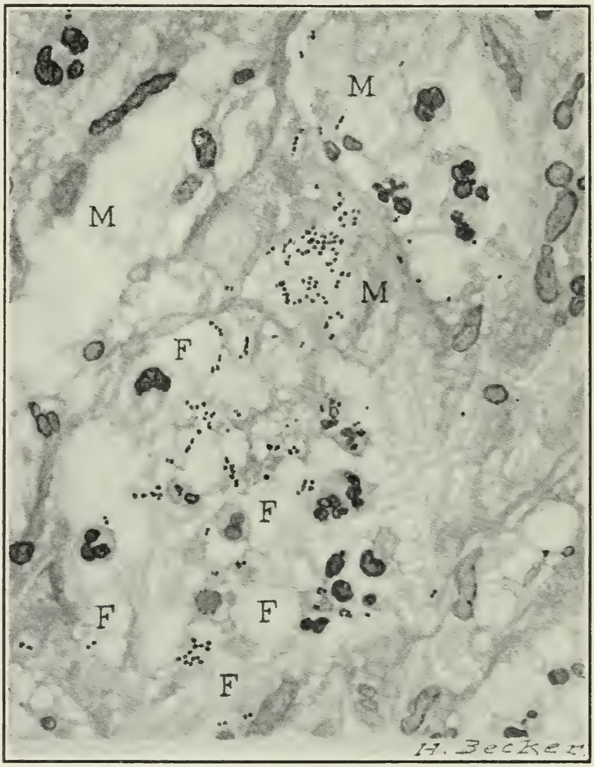


Fig. 177.—Transmission of Streptococci from Maternal Blood Spaces to Fœtal Vessels in Placenta of Rabbit (E. Philipp). × 1100.

Philipp has demonstrated experimentally that virulent streptococci may pass from mother to child, and Figure 177 shows them in both maternal and fœtal vessels. In other affections it would appear that transmission never occurs from mother to fœtus. Thus in malaria and trypanosomiasis there is no evidence that the specific parasites can pass from the maternal to the fœtal blood. On the other hand, Philipp has adduced experimental evidence that the Spirochæta of relapsing fever, as well as the Spirochæta icterogenes quite frequently pass, and that very exceptionally the Spirochæta pallida may do likewise.

The transmission of materials from the fœtus to the mother has also been experimentally demonstrated for animals. Thus Savory and Gusserow showed, by injecting strychnine into embryos still within the uterus, that the mother died within a short time from strychnine poisoning. Similar results were also obtained by Preyer with hydrocyanic acid, and by Nicloux with alcohol.

The Nature and Functions of the Amniotic Fluid.—In addition to the materials received from the placenta, it is generally believed that the fœtus obtains a great part of the fluid necessary for its development from that contained in the amniotic sac. Spiegelberg, Ahlfeld, Zweifel, and others have demonstrated that considerable quantities of it are swallowed, inasmuch as they found lanugo hairs, epidermic cells, etc., in the stomach and intestines of the fœtus. Ahfeld believes that the amniotic fluid is swallowed in such large quantities that even the small amount of albumin which it contains aids in the nutrition of the fœtus; but this point is very doubtful. Besides this function, the amniotic fluids plays an important part by surrounding the fœtus with a medium of constant temperature, which serves to prevent loss of heat, while at the same time affording a protection against sudden shocks from without. It also serves an important function by preventing the formation of adhesions between the fœtus and the walls of the amniotic sac, which, when they occur, may give rise to serious deformities.

According to Hoppe-Seyler, the amniotic fluid is clear, alkaline in reaction, having a specific gravity of 1.006 to 1.0008, and consisting of 98.48 per cent water, 0.19 per cent albuminoid material, 0.556 per cent soluble inorganic salts, 0.8 per cent extractives, and 0.024 per cent insoluble organic salts.

Unfortunately it is impossible at this time to make positive statements concerning the origin of the amniotic fluid in women, and those interested in the subject will find our knowledge up to 1912 well summarized in the articles of Ahlfeld, and Wagner. From time to time four main views have been advanced as to its origin: (1) fœtal urine; (2) transudation from maternal blood; (3) secretion through the amniotic epithelium, and (4) a mixed origin.

The first view was advocated in the seventeenth century by Portal, and has had many adherents until recently. Practically all investigators agree that the fœtal kidneys are capable of functioning in the later months of pregnancy, and undoubtedly do so under abnormal conditions, notably in certain cases of uniovular twin pregnancy. On the other hand, the fact that the amniotic fluid is present in very early ova, even before the development of the embryonic area, as well as before the development of the fœtal kidneys, clearly indicates that in early pregnancy at least some other origin must be sought. Furthermore, the occurrence of dropsical ova, in which all trace of the fœtus has disappeared, while the amniotic sac is distended by fluid, forces us to a similar conclusion. Finally analysis of the amniotic fluid shows that it contains very small quantities of urea, and indicates, if it is fœtal urine, that it differs very markedly from that excreted during extra-uterine life. At the same time, it must be admitted that occasionally the amniotic fluid may be admixed with urine in normal pregnant women, as is shown by the occasional findings of uric acid crystals upon microscopical examination of the sediment obtained by centrifugalization.

The question has also been approached experimentally, particularly by Schaller. This observer availed himself of the well-known fact that the administration of phloridzin gives rise to a transitory diabetes, which results from the action of the drug upon the renal epithelium and not from changes produced in the blood. He showed that after the drug had been injected into the mother its presence could readily be demonstrated in the tissues of the fœtus, while the amniotic fluid rarely contained traces of sugar, which should have been present in large quantity had the fœtal kidneys functioned.

Until very recently many authorities believed that the amniotic fluid was in great part a transudation from the maternal vessels. Probability is lent to such a view by the fact that an excessive quantity of amniotic fluid is present in certain dropsical conditions of the mother, but more particularly by the results following the injection of certain substances into the maternal circulation. When potassium iodide or sodium indigosulphate is so injected the substance promptly appears in the amniotic fluid, but no trace can be demonstrated in the fœtal kidneys. Furthermore, glucose is frequently present in the amniotic fluid of women suffering from glycosuria, while it is uniformly absent in normal pregnancy.

On the other hand, the fact that Zangemeister and subsequent investigators have found that the freezing point of the amniotic fluid is lower than that of the maternal serum clearly indicates that the one cannot be derived from the other by mere filtration. Consequently, since the bulk of the amniotic fluid does not consist of fœtal urine nor represent a transudate from the maternal serum, its only possible source must be direct secretory activity on the part of the amniotic epithelium.

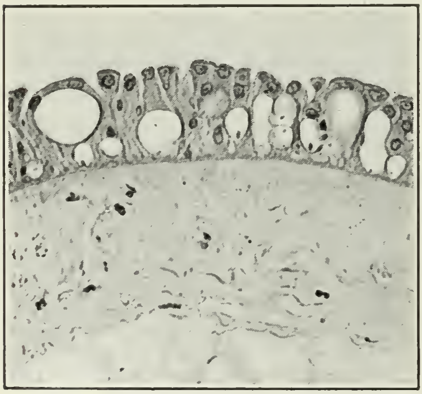


Fig. 178.—Vacuoles in Amniotic Epithelium Indicating Secretory Activity.

This was first rendered probable by histological examination by Polano, Bondi, Mandl and others in certain cases of hydramnios when changes were noted in the amniotic epithelium, which could only be interpreted as manifestations of secretory activity. Later, Polano and I found that in normal pregnancy the amniotic epithelium frequently exhibits a very striking formation of vacuoles, whose contents at times can be seen in the act of being extruded into the amniotic sac (Fig. 178). Such changes occur so frequently that they must indicate some physiological function, and thus lend further support to the secretory theory. Moreover, by appropriate methods of staining, Polano was able to demonstrate the abundant presence of fat in the amniotic epithelium, and associated it with secretory activity (Fig. 179). Keiffer likewise observed similar formations, which he is inclined to connect with the production of the vernix caseosa. In my laboratory similar observations have been made, but rarely to the extent noted by Polano and Keiffer. In any event, the occurrence of such changes negatives our earlier conception that the amniotic epithelium is primarily a dialysing membrane.

Likewise, the investigations of Goldmann, and Evans upon "Vital staining" point to a similar conclusion. Upon injecting pregnant animals with pyrrol-blue, these observers found that the internal organs and external surface of the mother took on a blue stain, while in the fœtus the coloration was limited to the external surface and to the lining of the intestinal canal. At the same time the amniotic fluid was blue and the amniotic epithelium pigmented. They accordingly concluded that the pigment gained access to the amniotic fluid through the amniotic epithelium, and that the pigmentation of the fœtus was due to the fact that it was bathed by the colored liquor amnii, which it also swallowed. That the fluid did not represent fœtal urine was demonstrated by the absence of pigment from the vesical and renal epithelium.

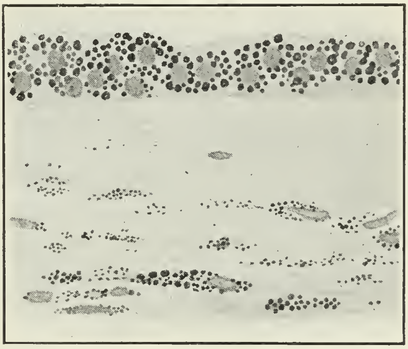


FIG. 179.—FAT IN AMNIOTIC EPITHELIUM (Adapted from Polano).

Finally, it should be borne in mind that a part at least of the amniotic fluid may represent a transudation through the surface of the fœtus or through the vessels of the cord; and, furthermore, as shown by the experiments of Wolff, that the fœtal kidneys may function if those of the mother become insufficient. Wagner, however, has shown that in experimental animals mere renal insufficiency on the part of the mother is not sufficient to cause the fœtal kidney to function, but that it does occur after double nephrectomy, or after the removal of three-quarters of the kidney substance.

Accordingly, from the evidence at present available, it would appear that under normal conditions the amniotic fluid is derived primarily from the maternal serum, which is modified during its passage through the amniotic epithelium; but that under abnormal conditions other sources, more particularly the fœtal urine, will have to be taken into consideration.

Respiratory and Digestive Functions.—From the studies of Stander it would appear that the fœtus *in utero* obtains its energy almost entirely from carbohydrates, with the result that its respiratory quotient is approximately unity. For this reason it requires a relatively small quantity of oxygen to support life, so there is but little tissue waste. Again, the fact that it is surrounded by amniotic fluid makes it necessary for the fœtus to produce but little warmth, as only a small amount of energy is expended during its restricted movements. Its need of oxygen, however, is demonstrated by the rapid occurrence of death, with symptoms of asphyxia, whenever the circulation of the umbilical cord is interfered with for even a short time.

It has been demonstrated that the fœtus actually produces warmth, as Wurster showed that its temperature exceeded that of the interior of the uterus by 0.5° C. or 0.9° F. Champion, in 1903, arrived at a similar conclusion, and put the difference at 1° F.

Very little is known concerning the functions of the intestinal tract of the fœtus, though it has been demonstrated that the stomach contains pepsin and rennin after the fifth month, their presence indicating a certain amount of glandular activity. The large amount of blood which circulates through the liver would go to show that this organ serves some important purpose, and the formation of bile is conclusively demonstrated by the presence of biliary materials in the meconium.

While the fœtus remains in the uterus its movements are restricted within narrow limits, though such undoubtedly occur, being felt by the mother as "life" from the middle of pregnancy, and at a little later period by the physician when he places his hand upon the abdomen. By the use of the sphygmograph, Ahlfeld demonstrated that the fœtus makes very rapid superficial movements—at the rate of sixty to the minute—which he considered represented an abortive type of respiration; but his conclusions have not been generally accepted, and we are still in doubt as to the significance of his observations.

Sex of the New-born Child.—Statistics show that more boys are born at full term than girls, the proportion, according to the figures given by Rauber, being 106 to 100. Ahlfeld has pointed out that this ratio is still further increased in elderly primiparæ. Furthermore, it is well known that in abortions and premature labors the males still further outnumber the females. In 1200 specimens of abortion in the Carnegie Laboratory of Embryology, Schultz found that the sex ratio was 110 to 100, while Crew estimates it at 170 to 100 at the onset of pregnancy, thus indicating a specifically greater mortality in the case of males. For these reasons, Schultz suggested the advisability of distinguishing between primary, secondary and tertiary sex ratios: the first representing the conditions immediately following conception, the second those at full term, and the third those at any specifically chosen period of later life.

Until recently we were almost absolutely ignorant concerning the causation of sex, though it was generally believed that it did not become established until some time after fertilization. Recent investigations, on the other hand, clearly show that this is not the case, but that sex is determined in the germ cells, either primarily or immediately after their union, so that it has become immutable by the time segmentation of the ovum begins.

In the first place, support is lent to such a view by observations upon twin pregnancy in human beings. It has long been known that these result either from the fertilization of one or of two ova, and that a positive distinction can be made by the study of the fœtal membranes. In the first case the children are always of the same sex, whereas in the latter the sex may or may not be the same. Furthermore, still more striking evidence is afforded by the armadillo. In this animal each litter consists of four young which are always of the same sex, and that they are derived from a single ovum, is shown by the fact there is only one placenta and one chorion, but four amnions. While such observations show that the sex had been determined before segmentation had begun, they give no information as to the mechanism of its determination, and leave us doubtful whether it had been predetermined in the ovum or in the spermatozoön, or was due to changes taking place at the time of fertilization.

Morgan, Doncaster, and Swingle have given excellent reviews of the subject, and have pointed out that all these eventualities are possible. Doncaster lays particular stress upon the influence of the egg, and points out that male and female eggs occur in many species, and have been demonstrated particularly in birds and Lepidoptera. In such animals the two types of eggs can be readily distinguished.

On the other hand, Morgan, Wilson, Stevens, Boveri, Winiwarter, Painter, and Evans contend that in many species, including man, the determining factor must be attributed to the spermatozoön. These investigators have carefully studied the arrangement of the chromosomes in numerous species, and have discovered that they are differently arranged in the germ cells. Thus, in the oöcytes, the chromosomes are always in pairs of similar appearance, while in the spermatocytes three types may be observed. In the first type one of the chromosomes is without a mate; in the second, the chromosomes in one pair may vary in size, one being larger than its mate; while in the third, no difference can be detected. Accordingly, when reduction occurs in the formation of the spermatozoa, two varieties of spermatozoa will occur in each of the first two types, while in the third there will be no variation. In the first type one variety of spermatozoa will contain one less chromosome than the other; in the second both varieties will contain the typical number, but one will possess an aberrant, or small chromosome, while in the other all the chromosomes will be similar. According to Wilson's theory, sex will depend upon which variety of spermatozoön effects fertilization: those with identical chromosomes giving rise to females, and those lacking a chromosome, or provided with a small one, giving rise to males. Whether the determination is affected solely by the spermatozoön, or whether it merely brings to the ovum certain substances which set in motion tendencies which already existed, is not yet known. In the latter event, the determination of sex must eventually prove to be a function of the ovum.

Reference has already been made to the investigations of T. S. Painter and of Evans upon spermatogenesis in man, which show beyond peradventure that the spermatocytes of the first order contain 48 chromosomes one of which is of the "x-y" variety (Figs. 180 and 181). Consequently, when the reduction division occurs, two types of spermatozoa will develop, each containing twenty-four chromosomes, but differing from one another by the fact that one type contains an x chromosome and the other a y chromosome. As all of the chromosomes of the mature ovum are of one type, it is apparent that after fertilization we may have to deal with two types of zygotes—one containing 46 typical and 2 x chromosomes, while the other contains an x and a y chromosome, the first developing into a female and the second into a male. In other words, for practical purposes, spermatozoa containing the x chromosome may be regarded as female and those containing the y chromosome as male spermatozoa.

As each spermatocyte, at the reduction division, gives rise to two spermatozoa—one of which is male and the other female—it would appear that male and female children should be produced in equal numbers, and yet we know that the primary sex ratio is 100 females to 170 males, which diminishes to a secondary ratio of 100 to 106 at the time of birth. Why this is so, we are unable to state; but such a result might be attributed to a selective mortality on the part of the female spermatozoa, whereby the probability of fertilization by spermatozoa containing the x chromosome would be reduced. Or, as Crew suggests, it is possible that the spermatozoa possessing a y chromosome have greater penetrating power, so that they are more likely to effect fertilization than the other type.

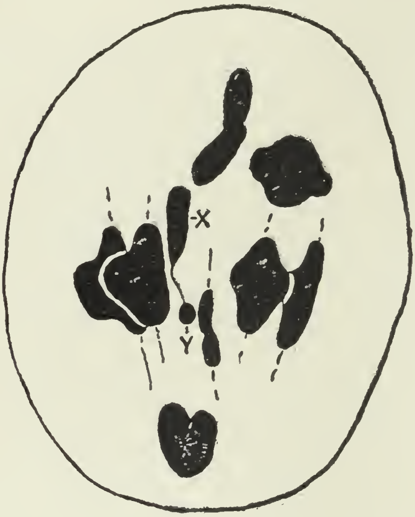


Fig. 180.—Portion of Human First Spermatocyte Spindle Showing the X-Y Sex Chromosomes among the Tetrades (Painter).

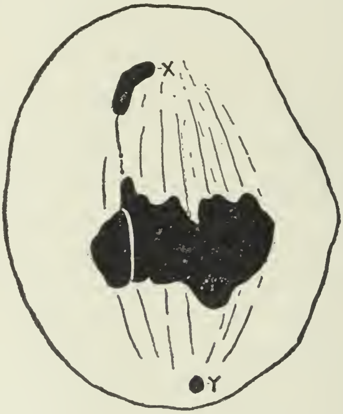


Fig. 181.—First Maturation Division Showing Segregation of X and Y Chromosomes to Opposite Poles of the Human First Spermatocyte Spindle (Painter).

Whatever the explanation may be, there seems every ground for believing that in human beings sex is determined primarily by the type of spermatozoön by which fertilization is effected.

Further evidence in favor of such a view is afforded by the study of so-called sex-limited inheritance, in which abnormalities or diseases, such as color blindness or hemophilia are transmitted from a man to his grandsons through the intermediary of his daughters. It would, however, lead too far afield to consider such problems, and those desiring further information are referred to special works on heredity.

In 1897, Schenk startled the world by stating that sex could be determined at will, as it was entirely dependent upon the condition of nutrition of the mother, and could therefore be influenced by appropriate dietetic treatment. The considerations just mentioned, however, show that his conclusions were visionary.

Reference might also be made to the erroneous, but widespread, belief that boys develop from eggs coming from the right ovary and girls from the left. Rumley Dawson, in a monograph which appeared in 1917, attempted to prove that the two ovaries ovulate alternately, so that it is possible to control the sex provided the woman had previously given birth to a child. To do so, it is only necessary to remember that, at the first ovulation following labor, the ovum would come from the ovary which had not functioned at the last conception. Accordingly, if the child were a boy, the next ovum would be from the left ovary, so that by making the necessary calculation coitus could be had when the right or left ovary was to function, according as a boy or girl was desired.

That such teaching is erroneous is demonstrated by the fact that women from whom one ovary has been removed continue to have children of either sex, and Murray, from my own material, conclusively showed the fallacy of such a belief. Moreover, I have for years made it a practice to note at cæsarean sections which ovary contains the corpus luteum, and have found that it is a matter of indifference whether it is situated on the right or left side so far as the sex of the child is concerned. For example, in 64 observations the corpus luteum was found 36 and 28 times in the right and left ovary respectively. In the first instance, there were 23 boys and 13 girls, while in the second there were 16 and 12, respectively, thereby conclusively demonstrating that children of either sex may develop from eggs coming from either ovary.

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SECTION III

PHYSIOLOGY OF PREGNANCY

CHAPTER VI

CHANGES IN THE MATERNAL ORGANISM RESULTING FROM PREGNANCY

It should be constantly borne in mind that pregnancy is not a mere local condition affecting the genitalia, but is a process associated with fundamental changes in the entire organism. Ordinarily, one fails to realize how radical these changes are, and to how great an extent the childbearing woman differs from man. The contrast was strikingly illustrated by Sellheim when he estimated that a woman who has borne six children has produced by her generative function—including menstruation, but excluding the production of milk—an amount of tissue twice as great as her original weight.

Every portion of the maternal organism reacts to a greater or lesser extent under the influence of pregnancy. Formerly, these changes were attributed in great part to nervous impulses originating in the pregnant uterus, but more extended clinical observation and experimental work show that such is not the case, and indicate that such changes can be explained only by the supposition that they are in some way connected with the circulation in the blood of substances concerning whose nature we are as yet ignorant.

UTERUS

Naturally the most apparent changes are observed in the generative tract, and especially in the uterus, which undergoes a very great increase in size. Thus, it is converted from a small, almost solid organ, 6.5 centimeters long, into a thin-walled, muscular sac, capable of containing the fœtus, placenta, and a large quantity of amniotic fluid, and at the end of pregnancy is about 32 centimeters long, 24 centimeters wide, and 22 centimeters deep. Krause estimated that its capacity is increased 519 times. A corresponding increase in weight is also observed, the uterus at full term weighing in the neighborhood of 1000 grams (2 pounds), as compared with 30 grams (1 ounce) in the virginal condition.

This enlargement is due principally to the hypertrophy of preëxisting muscle cells, but partly also to the formation of new ones during the earlier months of pregnancy. The fully developed muscle fibers are from 2 to 7 times wider and from 7 to 11 times longer than those observed in the nonpregnant uterus, measuring 0.009 to 0.014 × 0.2 to 0.52 millimeter in the former, as compared with 0.005 × 0.05 to 0.07 millimeter in the latter. According to the researches of Luschka and Veit, the formation of new muscular fibers is limited to the first three or four months, but Stieve believes that it occurs throughout the entire duration of pregnancy.

With the increase in the number and size of the muscle fibers is associated a marked development of mysenchymal tissue between the muscle bands, particularly in the external muscular layer, which resembles embryonic connective tissue. At the same time there is a considerable increase in the amount of elastic tissue, D'Erchia having shown that it forms a network about the various muscle bundles, which hypertrophies with advancing pregnancy, and thus adds materially to the strength of the uterine walls. At the same time there is a great increase in the size of the blood vessels, especially the veins, which, in the neighborhood of the placental site, become converted into large spaces, the so-called placental sinuses. Marked hypertrophy of the lymphatic and nervous supply of the uterus also takes place, which is well illustrated by the increase in size of Frankenhäuser's cervical ganglion from 2 × 2.5 to 3.5 × 6 centimeters.

During the first few months the hypertrophy of the uterus, in all probability, is brought about by the circulation of certain substances derived from the product of conception or from the ovary. That it is not directly due to the presence of the ovum in the uterine cavity is shown by the occurrence of precisely similar changes in extra-uterine pregnancy, when the ovum is implanted in the tube or ovary. After the third month, however, the increase in size is in part mechanical, and is due directly to the pressure exerted by the growing product of conception.

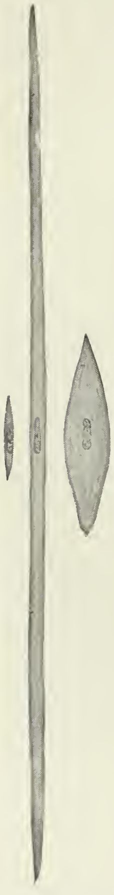


Fig. 182.—Muscle Fibers from Normal Nonpregnant, Pregnant and Puerperal Uterus (Stieve).

During the first few months of pregnancy the uterine walls are considerably thicker than in the nonpregnant condition, but as gestation advances they gradually become thinner, so that at the end of the fifth month they are from 3 to 5 millimeters in thickness. This measurement is retained throughout the succeeding months, so that at term the walls of the body of the uterus are rarely above 5 millimeters thick, and occasionally they measure considerably less. Consequently the organ soon loses the firm, almost cartilaginous consistence which is characteristic of the nonpregnant condition, and in the later months becomes converted into a muscular sac having very thin, soft and readily compressible walls. This is well demonstrated by the ease with which the fœtus can usually be palpated in the later months, and by the readiness with which the uterine walls yield to the movements of the fœtal extremities.

The enlargement of the uterus is not symmetrical, but is most marked in the fundal region. This can readily be appreciated by observing the relative positions of the insertions of the tubes and ovarian ligaments, which in the early months of pregnancy are only a little below the level of the fundus; whereas in the later months their attachments are found at points slightly above the middle of the organ.

The position of the placenta also exerts a determining influence upon the extent of the hypertrophy, the portion of the uterus to which it is attached enlarging more rapidly than elsewhere. This is clearly shown by the position of the uterine ends of the round ligaments, which are close together when the placenta is inserted upon the posterior, and far apart when it is upon the anterior wall.

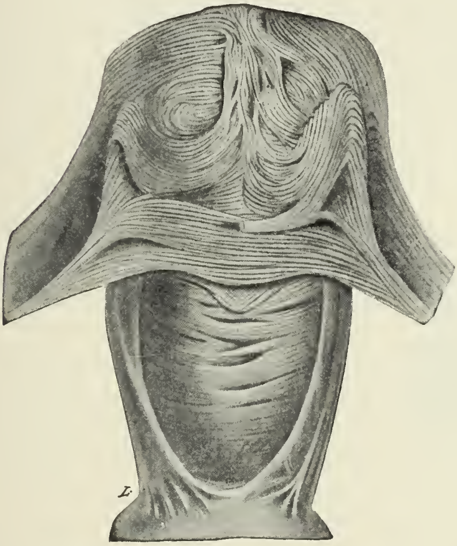


FIG. 183.—EXTERNAL MUSCULAR LAYER OF PREGNANT UTERUS (Hélie).

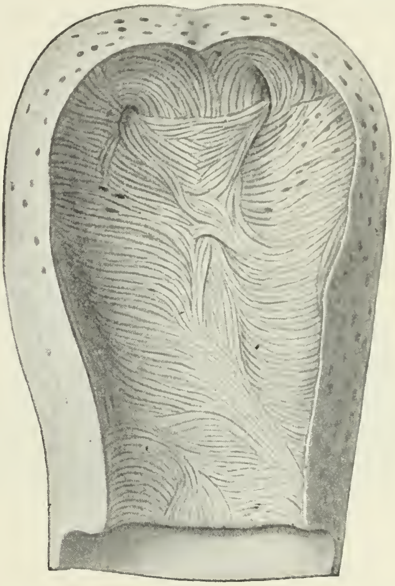


FIG. 184.—INTERNAL MUSCULAR LAYER OF PREGNANT UTERUS (Hélie).

Arrangement of the Muscle Fibers.—Ever since the time of Vesalius, considerable attention has been devoted to the arrangement of the muscle fibers in the pregnant uterus. Among the numerous investigators whose careful studies on this subject deserve special mention are William Hunter in England; Madame Boivin, Deville, and Hélie in France; Roederer, Luschka, Henle, Hoffman, Bayer, and Hofmeier, in Germany.

According to Luschka and Henle, the musculature of the pregnant uterus is arranged in three strata: an external hoodlike layer, which arches over the fundus and extends into the various ligaments; and an internal layer, consisting of sphincterlike fibers around the orifices of the tubes and the internal os; while lying between the two is a dense network of muscle fibers perforated in all directions by blood vessels.

The most important contributions, however, we owe to Hélie, Bayer, and Ruge. In the preface to his monograph Hélie states that he had devoted twelve years to his investigations, and Bayer was an indefatigable worker upon the subject for forty years.

According to Hélie, the uterine musculature consists of three main layers, each of which is made up of several subsidiary divisions. The external layer is composed of two longitudinal or ensiform portions, between which lies a transverse layer. The internal layer is composed of two triangular portions running along the inner surface of the anterior and posterior walls of the uterus respectively, and connected by an archiform layer at the fundus, an orbicular portion around each tubal opening and an annular layer around the internal os. The main portion of the uterine wall is formed by the middle layer, which consists of an interlacing network of muscle fibers, between which extend the blood vessels. Each fiber comprising this layer has a double curve, so that the interlacement of any two gives approximately the form of the figure "8." As a result of such an arrangement, it happens that when the fibers contract after delivery they constrict the vessels and thus act as living ligatures.

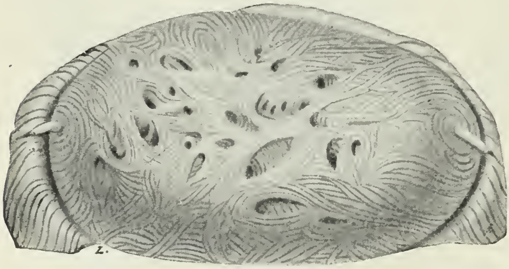


Fig. 185.—Median Muscular Layer of Pregnant Uterus (Hélie).

Ruge pointed out that many of the layers which had been described by previous observers do not exist as such in the pregnant uterus, the appearances having resulted from the manner in which the dissections had been made. He showed that the muscle fibers composing the uterine wall, especially in its lower portion, overlap one another and are arranged like shingles on a roof, one end of each fiber arising beneath the peritoneal covering of the uterus, and extending obliquely downward and inward, to be inserted into the decidua, thus giving rise to a large number of muscular lamellæ. The various lamellæ are connected with one another by short muscular processes, so that when the tissue is slightly spread apart it presents a sievelike appearance, which on closer examination is seen to be due to the presence of innumerable rhomboidal spaces.

The outermost layer of the uterine musculature can be especially well appreciated at the time of cæsarean section. When the uterus contracts down after the delivery of the child and placenta, it is seen that the superficial margins of the incision retract some millimeters beyond the bulk of the muscular wall, and it is this layer which is brought together by the superficial suture. Upon microscopical examination it is in turn found to be made up of several thinner layers—an outermost layer consisting of muscle bundles running vertically, a median layer running circularly, and beneath the latter a thicker layer of loosely interlacing fibers, separated from one another by loose connective tissue, and including many vessels. Indeed, the latter are so abundant, that this layer may appropriately be designated as the stratum vasculare.

Hofbauer, in 1929, called attention to the fact that some of the vertical fibers, in the midline of the anterior and posterior walls of the uterus, form a peculiar tænialike band just beneath the peritoneum. These fibers present a vacuolated structure, stain differently from the rest of the fibers and strongly suggest some relationship with the specialized structures in the heart constituting His' bundle. He even suggests that they may have a similar function, and in some way act as the "pacemaker" for the uterine contractions. While there is no doubt concerning the presence of such structures, further experimental work will be necessary before their function can be regarded as established.

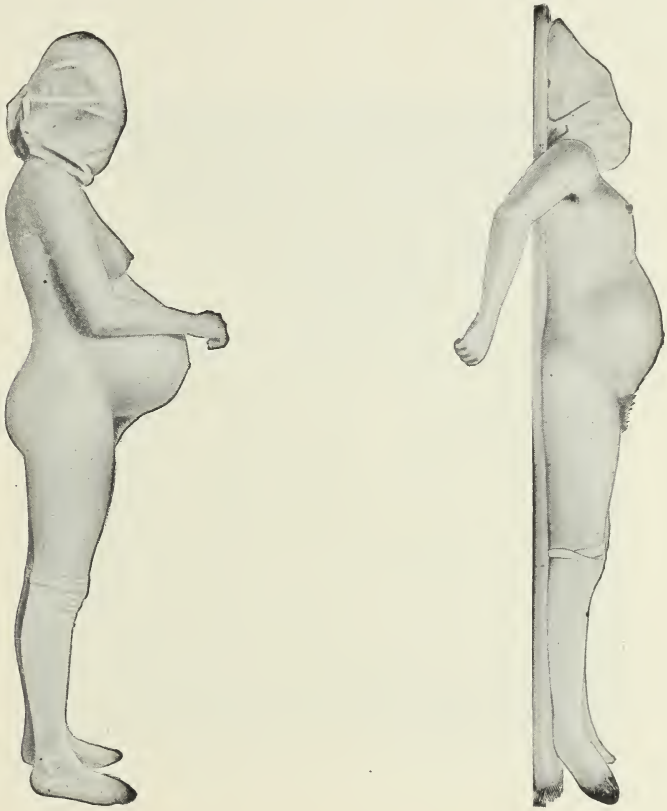


Fig. 186. Fig. 187.

Figs. 186 and 187.—Same Full-term Primipara in Vertical and Horizontal Position.

Changes in Size and Shape of the Uterus.—As the uterus increases in size, it also undergoes important modifications in shape. For the first few weeks its original pyriform outlines are retained, but the body and fundus soon assume a more globular form, which at the third month becomes almost spherical. After this period, however, the organ increases more rapidly in length than in width, and assumes an oval form, which persists until the end of pregnancy.

As the body of the uterus becomes larger, the angle which it forms with the cervix becomes more acute—in other words, its physiological anteflexion is increased. By the fourth month the organ becomes too large to be contained in the pelvic cavity, and forms a tumor, the upper border of which reaches midway between the symphysis pubis and the umbilicus. As it becomes still larger, it comes in contact with the anterior abdominal wall, displacing the intestines to the sides of the abdomen, and gradually rises up until it almost impinges upon the liver. As the uterus leaves the pelvis for the abdominal cavity, considerable tension is exerted upon the broad ligaments, which then become more or less unfolded at their median and lower portions and thus contribute to the mobility of the pelvic peritoneum, which is characteristic of pregnancy.

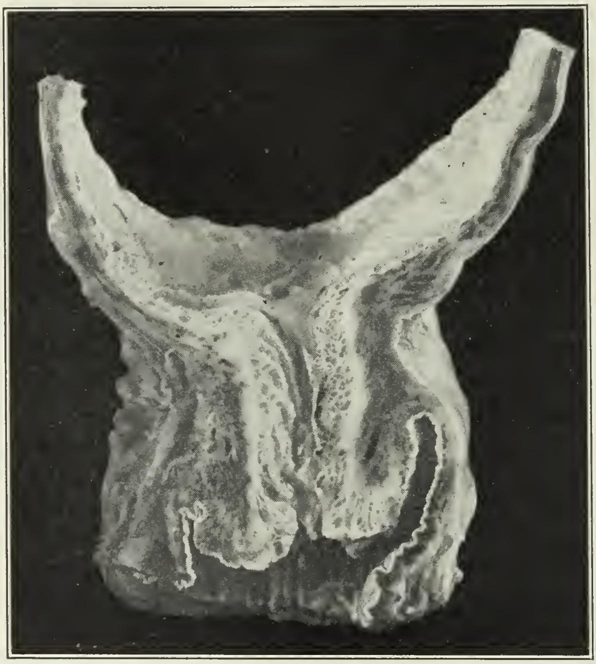


Fig. 188.—Section through Cervical Canal and Lower Part of Uterine Cavity from Patient 7½ Months Pregnant, Showing Hypertrophy of Mucosa. × 1½.

The pregnant uterus possesses a considerable degree of mobility. Since its upper portion projects into and lies free in the abdominal cavity, and its lower portion is held in check by the cervical attachments, it readily changes its position. With the woman in a standing posture its longitudinal axis corresponds closely with that of the superior strait, the organ resting in great part upon the anterior abdominal wall; but, when lying on her back, the uterus falls backward and rests upon the vertebral column. Figs. 186 and 187 represent the same woman in these positions respectively, and give a good idea of the changes in contour of the abdomen.

As the uterus grows out of the pelvic cavity, it usually rotates slightly to the right, so that its left margin is directed more anteriorly than the right. Occasionally the torsion may be in the opposite direction, statistics showing that it occurs to the right in 80 per cent and to the left in 20 per cent of the cases. The torsion is due in great part to the presence of the rectum, which occupies the left side of the pelvis; though occasionally the condition may represent merely an exaggeration of the original position of the nonpregnant uterus, which, as is well known, is not always perfectly symmetrical.

Changes in the Cervix.—Prior to 1927, it was generally stated that, apart from pronounced softening, but slight changes occur in the cervix during the course of pregnancy; and until labor sets in it appears as a mere appendage to the enlarged body of the uterus. Stieve, however, has shown, and I agree with him, that such views are erroneous, and that most striking and important changes occur. In the first place, the cervical mucosa undergoes such marked proliferation that at the end of pregnancy it occupies approximately one-half of the entire bulk of the cervix, instead of only a fraction of it as at other times. Moreover, the septa separating the glandular spaces become progressively thinner, resulting in the formation of a honeycomb-like structure whose meshes are filled with tenacious mucus, so that when the so-called "mucous plug" is expelled at the onset of labor practically the entire structure is carried away with it. Furthermore, the glands in the neighborhood of the external os proliferate beneath the stratified mucosa covering the vaginal portion, and give the cervix the velvety consistence characteristic of pregnancy (Figs. 188 and 189).

In the second place the muscle fibers, instead of taking part in the hypertrophy of the body, actually diminish in number, although those which remain increase in size. At the same time, the connective tissue becomes looser and reverts to a younger stage; while in the third place, there is a great increase in the number of vessels, particularly veins, with the result that the cervical wall outside of its canal becomes converted into an almost erectile tissue.

Ectopic Decidua.—Following the description by Schmorl and Kinoshita in 1897 of small decidual nodules on the posterior surface of the pregnant uterus and on the adjacent peritoneum, it has become generally recognized that decidual formation occasionally occurs in various portions of the body.

Geipel, in 1928, described 40 personal observations of ectopic decidual formation, not only about the genitalia, but also in the pelvic lymph glands, omentum, diaphragm, appendix and spleen. In every fourth or fifth uterus removed at operation or autopsy at the end of pregnancy, I have found ectopic decidual formation. Usually this consists in the presence of small pale nodules varying from 1 to 3 millimeters in diameter just beneath the peritoneum covering the lower portion of the posterior wall of the uterus. Occasionally, however, they present a pinkish color and suggest minute adhesions which have been torn through; while very exceptionally the decidual formation involves large areas, which are reddish in color and at first glance suggest an inflammatory change (Fig. 190).

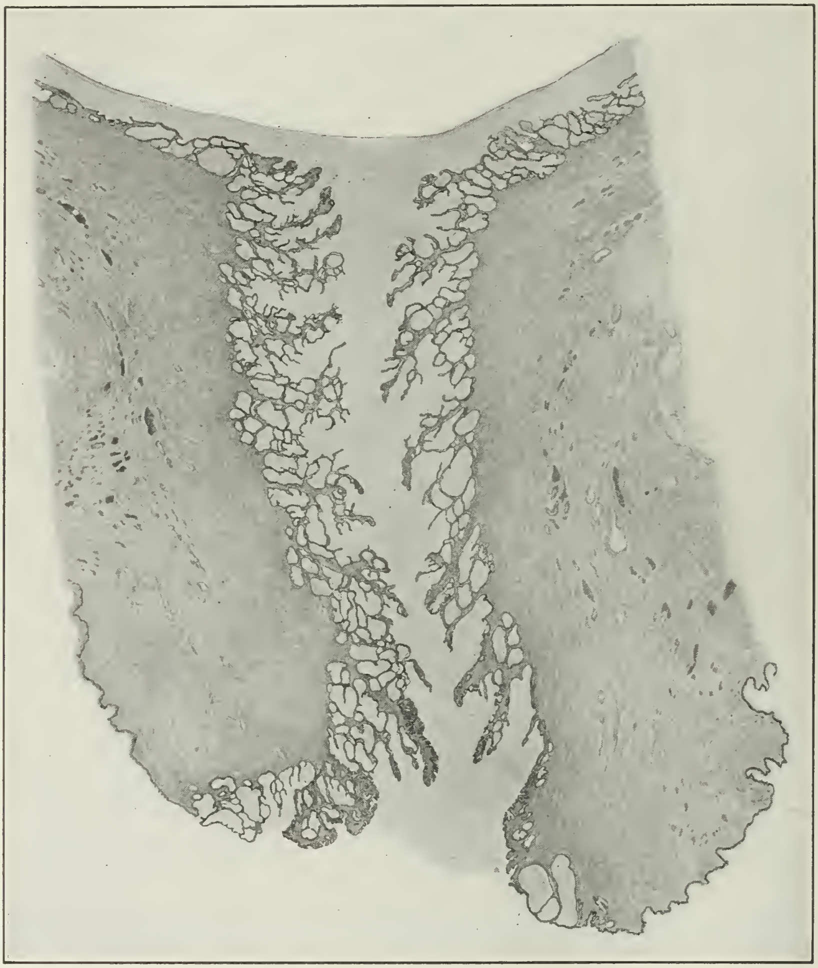


Fig. 189.—Fig. 188 More Highly Magnified, Showing the Extent to which the Cervix Late in Pregnancy is Composed of Hypertrophied, Honey-combed Mucosa.

Figure 191 represents a high-power reproduction of one of our specimens showing decidual formation in the omentum. In all such formations, the decidual cells lie beneath the peritoneum and afford convincing evidence that they are derived from the connective-tissue cells of the organ concerned. Why they arise or what their significance is has not been determined.

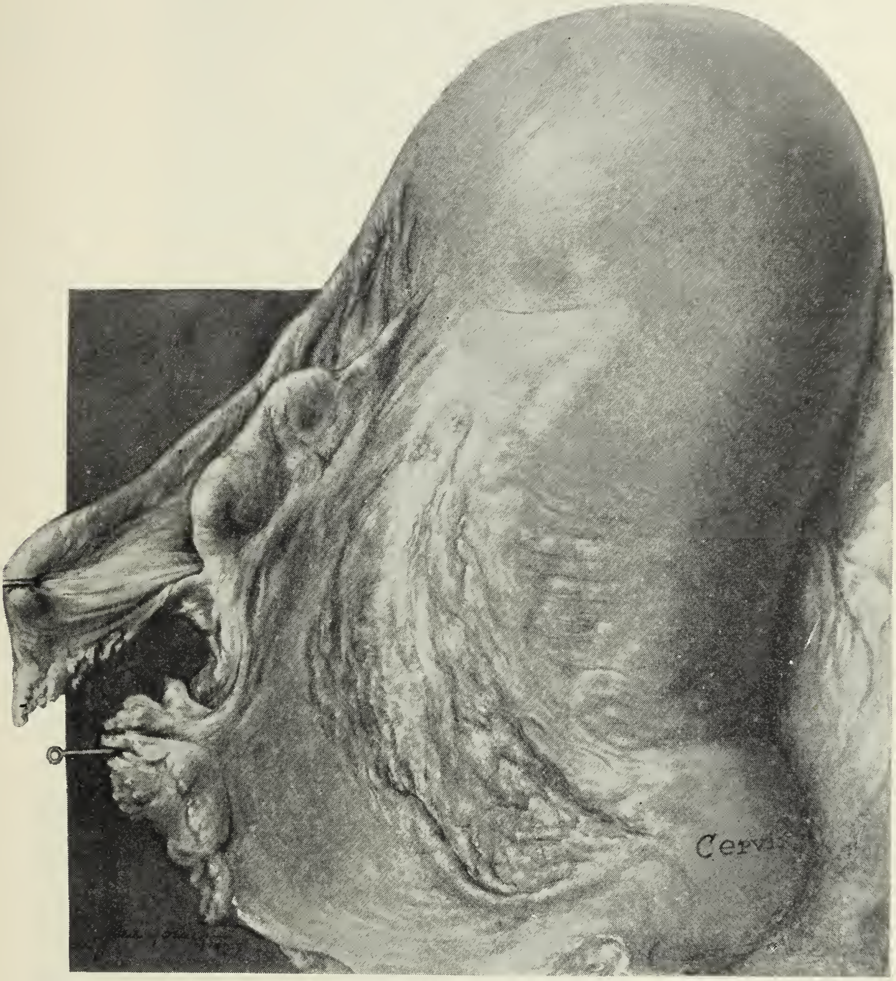


FIG. 190.—SHOWING ECTOPIC DECIDUAL FORMATION ON POSTERIOR SURFACE OF A PUERPERAL UTERUS. × ⅔. (Hofbauer.)

In this connection, reference might be made to the development during pregnancy of decidua in the endometrial islands occurring in adenomyomata far from the uterine cavity, to which I first called attention in 1905.

TUBES AND OVARIES

As has already been mentioned, the tubes and ovaries undergo marked changes in position with the advance of pregnancy, so that instead of extending

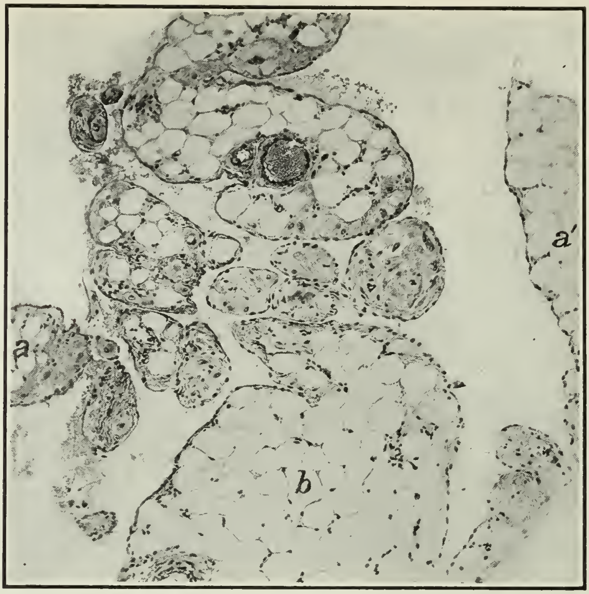


FIG. 191.—DECIDUA FORMATION IN OMENTUM (HIGH POWER).
a, decidual cells; *a'*, normal fatty tissue; *b,* decidual cells above, normal; omentum below.

outward almost at right angles from the cornua, their long axes become nearly vertical. Occasionally, as the result of the upward traction exerted by the

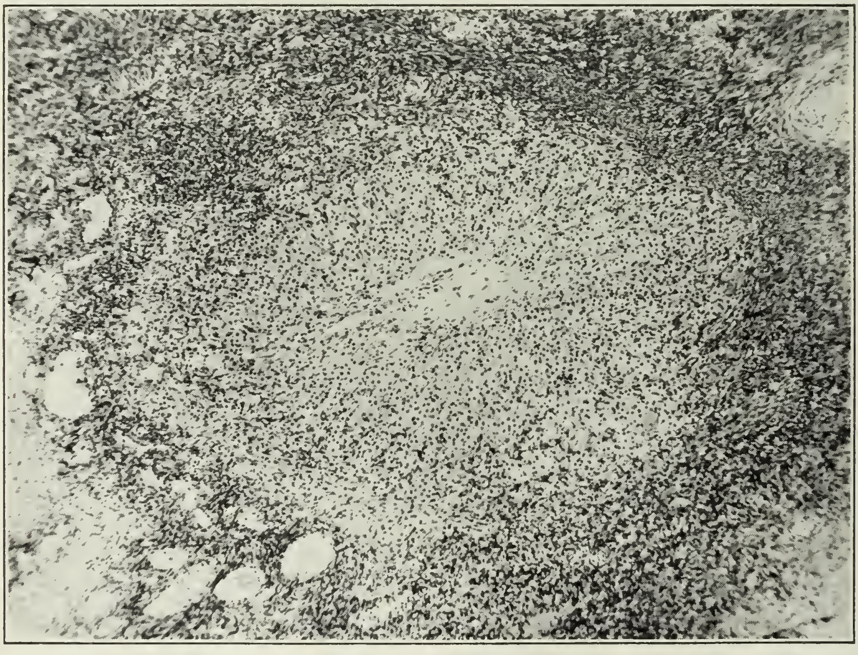


FIG. 192.—SECTION THROUGH OVARY OF PREGNANT WOMAN, SHOWING EXAGGERATED FOLLICULAR ATRESIA—THE SO-CALLED "INTERSTITIAL GLAND." × 60.

enlarging uterus, the ovaries become greatly elongated. More important, however, is their increase in vascularity, to which the large size of the corpus luteum of pregnancy is in great part due. It is generally believed that ovulation ceases during pregnancy, so that new follicles do not ripen, and, accordingly, only the single large corpus luteum of pregnancy can be found in one of the ovaries. Seitz, Walthard, Wallis, and others have shown that while typical ovulation does not occur, many follicles begin to grow and, after reaching a certain stage of development, undergo atretic changes, associated with a marked development of lutein cells in the theca folliculi. In many instances these cells come to occupy the greater part of the interior of the ovary, and are designated by many writers as the "interstitial gland." These forma-

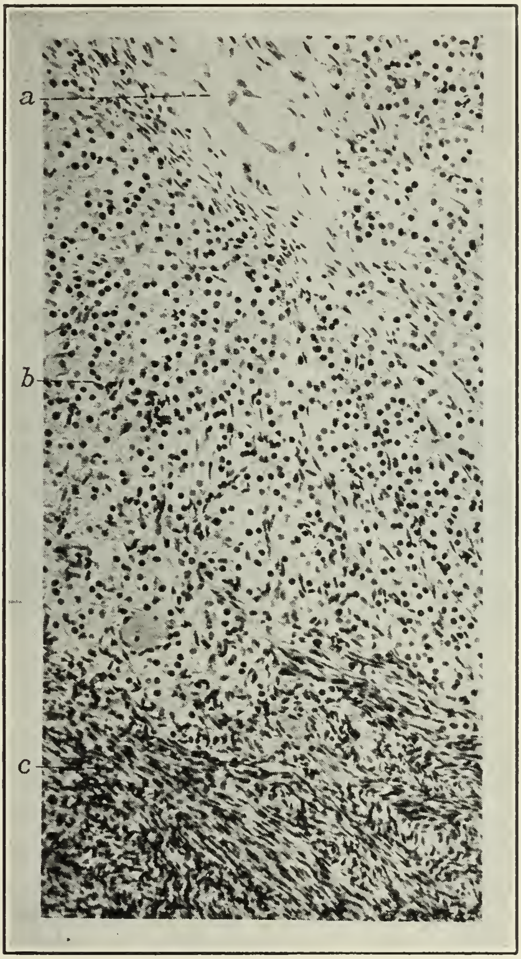
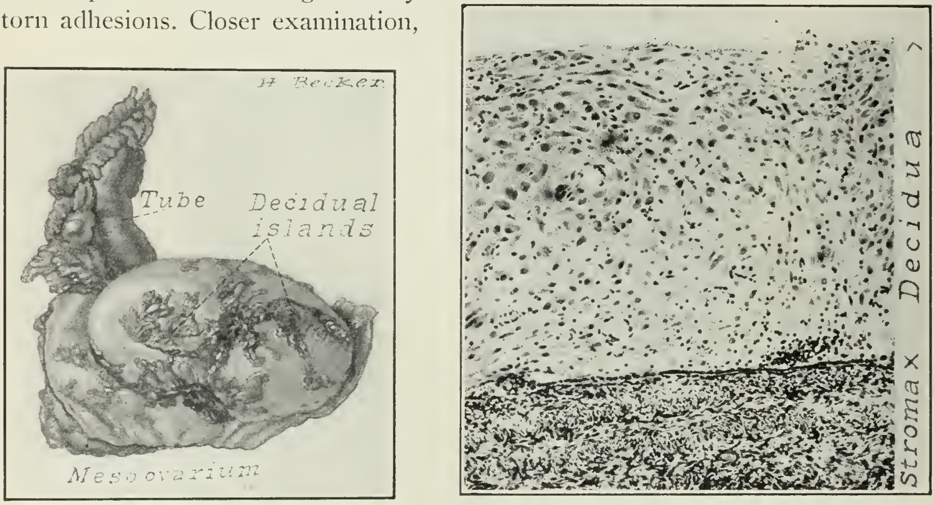


Fig. 193.—Portion of Figure 192, Magnified 200 Times.
a, connective tissue core; *b,* hypertrophied theca cells; *c,* normal ovarian stroma.

tions present so characteristic an appearance as to permit the experienced observer to make a diagnosis of pregnancy (Figs. 192 and 193). They disappear within a few weeks after labor, but from their structure it appears probable that they must have some important internal secretory function, although we are as yet ignorant as to what it is. Fellner states that the lipoids derived from them cause uterine hypertrophy when injected into experimental animals.

Inspection of the ovaries at cesarean section shows that in every third or fourth case a number of flattened pinkish elevations, rarely exceeding a few millimeters in diameter, project from their surface, and at first glance give the impression of being freshly torn adhesions. Closer examination, however, shows that they are not such, but that they consist of masses of decidual cells beneath the ovarian epithelium (Fig. 194). Their function is not known.



A B

Fig. 194.—A—Gross Specimen; B—Microscopic Picture of Decidual Formation on Surface of Ovary.

It is generally stated that the muscular fibers of the tubes undergo considerable hypertrophy under the influence of pregnancy, but I believe that Mandl is correct in stating that, if it occurs at all, it is very slight in extent. Moreover, the epithelium of the tubal mucosa is flatter during pregnancy than at any other period of reproductive life. Occasionally, in uterine pregnancy, decidual cells may develop in the stroma of the tubal mucosa, but they never lead to the formation of a continuous membrane, as in the uterus. Such observations are of extreme rarity, but I have made them in several instances.

VAGINA

Increased vascularity is the most marked change in the vagina, and to it are due the more copious secretion and the characteristic violet coloration of pregnancy. Stieve has shown that the vaginal wall undergoes very striking changes to prepare it for the distention incident to labor. He describes a considerable increase in the thickness of the mucosa, a great loosening of the connective-tissue elements, and an hypertrophy of the muscle cells to almost as great an extent as in the uterus. As a result, the vaginal walls may increase in length to such an extent that the lower portion of the anterior wall protrudes slightly through the vulval opening. The papillæ of the vaginal mucosa also undergo considerable hypertrophy, whence results an increased roughness of the membrane, which sometimes feels almost like a calf's tongue.

The vaginal secretion is considerably augmented, and normally is represented by a thick, white, crumbly substance, somewhat like cottage cheese, although purulent and fluid secretions are not uncommon. Döderlein first showed that the former type consists solely of epithelial cells and large numbers of long, tolerably thin bacilli—the so-called vaginal bacillus; while leucocytes and other bacteria occur only in the other types. The normal secretion is sharply acid in reaction, which Zweifel first showed is due to the presence of lactic acid. Kessler and Uhr of Schroeder's clinic, in 1927, studied the chemistry of the vaginal secretion, and state that it always contains lactic acid, glycogen, glucose and a diastatic ferment. They believe that the glycogen originating in the mucosa is the source of the glucose, and that the latter in turn is converted into lactic acid by the vaginal bacilli. They also state that the vaginal secretion is sharply acid, and presents a pH varying from 3.5 to 6, being highest in the abnormal secretions, and is always lower than that of the cervical mucus. They and all others who have worked upon the subject believe that the lactic acid plays an important part in keeping the vagina relatively free from pathogenic bacteria.

Whether the cellular contents of the human vaginal secretion undergo cyclical changes analogous to those observed by Long and Evans in the rat, and by other observers in various experimental animals, is not known, but the subject offers an interesting field for research.

The increased vascularity attending pregnancy is not confined to the genitalia, but extends to the various organs in their vicinity, and as a consequence there is a slight relaxation of the various pelvic joints, which is accompanied by an increase in their motility, as was conclusively shown by Budin.

Küstner has shown that the tissues in the perineal region likewise undergo hypertrophic changes in anticipation of the strain of labor, and that they consist in increased vascularity, hypertrophy of the skin and muscles, combined with a general loosening up of the elements constituting the connective tissue.

ABDOMINAL WALLS

With the enlargement of the uterus, the skin covering the anterior abdominal wall and the adjoining portions of the thighs is subjected to considerable tension, which, according to Zeiler, results in the rupture of the elastic fibers of the reticular stratum of the cutis, and the formation of depressed areas which are known as the *striæ of pregnancy*. In primiparæ these present a pinkish or slightly bluish appearance, as is well illustrated in Fig. 195, whereas in multiparæ two varieties are observed, some resembling those of primiparous women, while others present a glistening silvery appearance, the former resulting from the present condition, and the latter representing cicatrices from previous pregnancies.

Since 1923, a considerable literature has accumulated in connection with the striæ of pregnancy, and Sellheim and others claim that they are due less to passive stretching than to the fact that the skin cannot accommodate itself to the hypertrophic changes which occur in the abdominal walls under the influence of pregnancy. Certain force is lent to such contentions by the fact that striæ do not usually follow passive distention of the abdominal walls resulting from ascites or tumor formation, and more particularly by the constitutional studies of Seynsche, which show that they occur more frequently in the robust, pycnic types than in hypoplastic and asthenic women. According to Rodecurt they occur to a greater or less extent in over 80 per cent of all pregnant women, and it is believed that they can be prevented to some extent by

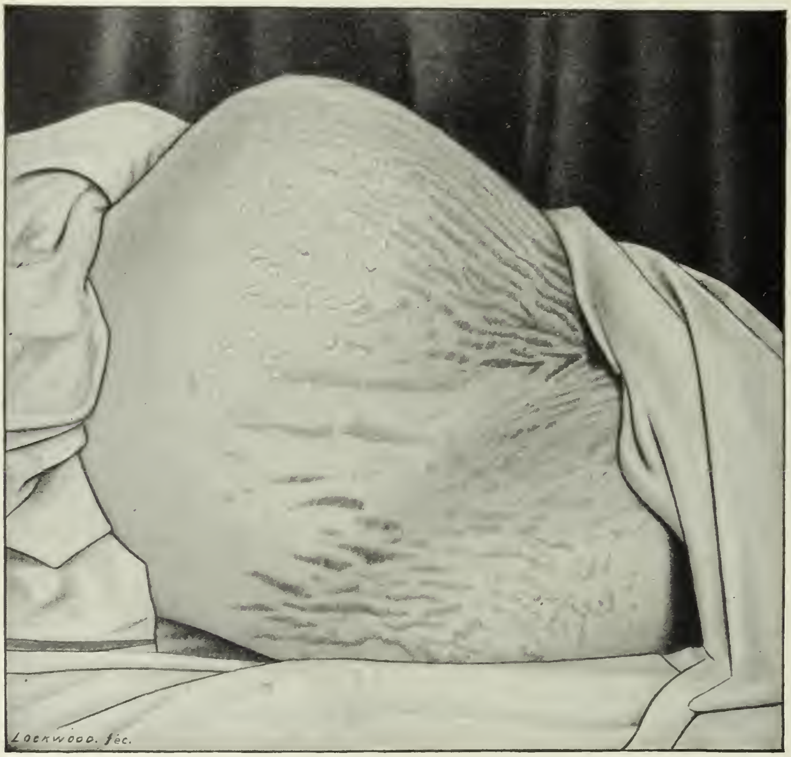


FIG. 195.—ABDOMEN OF PRIMIPARA AT TERM, SHOWING STRIÆ.

massaging the abdomen with some oleaginous substance and by the use of a properly fitting corset or abdominal support.

Not infrequently the abdominal walls are unable to withstand the tension to which they are subjected, and the recti muscles become separated in the middle line, giving rise to a *diastasis* of greater or less extent. Where the process is exaggerated, a considerable portion of the anterior wall of the uterus is covered by nothing beyond a thin layer of tissue consisting only of skin, fascia, and peritoneum. In rare instances the separation is sufficiently extensive to admit of a hernial protrusion of the gravid uterus.

BREASTS

Under the influence of pregnancy marked changes occur in the breasts, and in the early weeks the woman not infrequently complains of a sense of tenseness and pricking in these regions. After the second month the breasts begin to increase in size and offer a somewhat nodular sensation on palpation, which is due to the hypertrophy of the mammary alveoli, and as they become still larger a delicate tracery of bluish veins appears just beneath the skin. Even more characteristic, however, are the changes occurring in the nipples and the tissues in their vicinity. The nipples themselves soon become considerably larger, more deeply pigmented, and more erectile, and after the first few months a thin, yellowish fluid—*colostrum*—may be expressed from them by gentle massage. At the time the areola surrounding the nipple becomes considerably broader and much more deeply pigmented, the degree of pigmentation varying according to the complexion of the individual. In blondes the areolæ and nipples assume a pinkish appearance, while in brunettes they become dark brown and occasionally almost black. Scattered through the areola are a number of small roundish elevations, the so-called *glands of Montgomery,* which result from the hypertrophy of the sebaceous glands. In a small number of cases similar structures make their appearance in a less deeply pigmented area outside of the periphery of the areola, and which is designated as the *secondary areola.* If the increase in the size of the breasts be very marked, the skin frequently presents striations similar to those observed in the abdomen.

Formerly it was believed that direct nervous connection existed between the uterus and the breasts, but the demonstration that lactation can be established after excluding the spinal nervous mechanism by severing all nerves supplying the breast, or even after transplanting the organ to other portions of the body, clearly indicates that some other factor must be invoked in explanation of the mammary changes in pregnancy. Starling and Lane Claypon, in 1906, stated that they were able to produce definite hypertrophy of the breasts of virginal rabbits by the injection of extracts obtained from the bodies of fœtal rabbits, and attributed the result to certain specific hormones. Their conclusions were generally accepted until 1911, when Frank and Unger stated that they were unable to confirm them and attributed them to faulty observation and technic. However that may be, there is no doubt that the mammary changes characteristic of pregnancy must be due to the action of specific substances circulating in the blood, as was demonstrated by the observations of Schauta and of Basch upon the Blazek sisters. In this instance, one of the pygopagous twins gave birth to a child, which could be suckled equally well by its own mother or by its nulliparous aunt.

CHANGES IN THE REST OF THE BODY

As has already been indicated, the changes resulting from pregnancy involve nearly every portion of the body, and in many cases the general condition of the patient differs markedly from what it was before conception. Many women suffer numerous inconveniences, while others enjoy better health than at any other time.

Heart.—Owing to the upward pressure upon the diaphragm, the heart becomes displaced in such a way that its area of dullness undergoes a considerable increase in size. Basing his opinion upon this fact, Larcher, in 1827, promulgated the doctrine that considerable cardiac hypertrophy was a constant concomitant of pregnancy. His views obtained rapid acceptance in France, but only recently in Germany. Frey contends that x-ray measurement, bolometry and the increase in blood volume all indicate that the heart is enlarged. Moreover, Dreysel found that the hearts of 76 pregnant and puerperal women weighed 8.8 per cent more than those of normal individuals; while Jagie estimates that there is an average increase of twenty grams in weight, which he attributes to hypertrophy of the muscle fibers.

As it is generally admitted that the bulk of the blood is increased during pregnancy, it would seem that the demands of the enlarging uterus and its contents could be satisfied only by a more rapid circulation of the blood. As the pulse rate is not materially increased during pregnancy, it appears justifiable to conclude that such a result is accomplished by the heart expelling an increased amount of blood at each beat, which inevitably necessitates increased work, with coincident hypertrophy. This was definitely proved to be the case in dogs by Stander, Duncan and Sisson, who in this clinic found that the minute output of the heart was increased by one-third to one-half during the latter part of pregnancy.

Blood.—In former times it was generally believed that the changes incident to the placental circulation demanded an increase in the amount of maternal blood, and all the earlier writers stated that under the influence of pregnancy an increased hydremia and a diminution in hemoglobin and red corpuscles took place, while at the same time an abnormal amount of fibrin could be noted. These observations were based upon antiquated methods of research, and it was not until 1886 that Fehling, by the aid of modern appliances for examining the blood, came to the conclusion that it underwent little if any change.

Since then a number of articles have appeared, notably those of Payer, and

Dietrich, which show that in the later months of pregnancy the amount of hemoglobin and of red corpuscles is normal, or even slightly increased, while there is a slight increase in the number of white cells. The leukocytosis becomes markedly accentuated at the time of labor, but falls rapidly in the puerperium unless infection supervenes. Kühner, however, speaks of a physiological anemia of pregnancy, and believes that normal conditions are not restored until some months after delivery. His interesting contribution gives full literature upon the subject up to 1927.

Observations made in my clinic, in 1915, by Miller, Keith and Rowntree seem to show that during pregnancy there is a definite increase in both the plasma and blood volume, which disappears during the puerperium. These conclusions were based upon the injection of known quantities of "vital red" into the circulation, and the colorimetric comparison of the patients' serum with standard preparations of serum colored with the same dye. More extended, but as yet unpublished, observations by Harris in our service during 1922 and 1923, reënforce such conclusions, and demonstrate that the volume of blood is definitely increased, while the cell and hemoglobin content is relatively, but not actually, diminished.

Barcroft in 1930 made the interesting observation that in dogs during the second half of pregnancy the spleen becomes greatly diminished in size and regains its normal dimensions shortly after delivery. He is inclined to correlate the phenomenon with the normal increase in blood volume, and thinks that it probably occurs in women as well.

Plass and Matthews from the study of 314 women showed that the total plasma protein decreases 9.3 per cent from the beginning of pregnancy to the ninth month, rises at the time of labor, and regains its original figure during the third week of the puerperium. At the same time its several fractions differ in their behavior; the albumin fraction diminishing, the globulin fraction remaining essentially stationary, while the fibrin fraction increases, and attains its greatest height on the third day of the puerperium.

Eufinger has approached the problem from a physical-chemical point of view, and by means of the refractometer finds that the plasma colloids undergo a characteristic and progressive change towards the large dispersal phase. In other words, coincident with a relative decrease in the total protein, he finds an increase in the euglobulin and fibrinogen fractions. Both of these observations accord with the fact that the specific gravity of the blood is somewhat lowered, while the increase in fibrin may have some connection with the increased sedimentation rate of the blood in the latter part of pregnancy.

Following the discovery by Hasselbalch and Gammeltoft that the alveolar carbon dioxide tension is lowered in the latter part of pregnancy, as well as the observation by many observers that the carbon dioxide combining power of the blood is usually less than at other times, it is generally believed that even the normal pregnant woman suffers from an acidosis, which may become accentuated under abnormal conditions. The implications of such findings will be discussed under the heading of General Metabolism further on in this chapter.

The blood also contains various substances which are not present at other times, or which become greatly increased in amount during pregnancy. In this connection it may be noted that Gräfenburg, Clowes and Goldsborough, and others have demonstrated a definite increase in the antitryptic ferment content. Following the observations of Chauffard, Laroche and Grigand, all observers have noted a striking increase in the cholesterin content, which Slemons and Stander regard, at least in part, as a preliminary provision for lactation.

Furthermore, the discovery that the hormone of the anterior lobe of the pituitary is excreted in the urine in sufficient quantity to permit its utilization as a biological test for the diagnosis of pregnancy, indicates that it must circulate in the blood in considerably greater concentration.

Likewise, Heynemann and Ecalle state that there is a marked difference between the serum of pregnant and nonpregnant women, in that the former after heating will induce hemolysis of washed horses' corpuscles in the presence of cobra poisoning, whereas the latter will not. It was formerly believed that the adrenalin content of the blood was increased during pregnancy, but Neu has demonstrated that such is not the case. He has, however, shown the presence of a pressor substance in the serum, but not in the plasma, which he believes is histamine, which has originated during the changes connected with the coagulation of the blood.

Respiratory Tract.—According to Siegmund, Koblanck, and others, more or less characteristic changes may occur in the nasal mucosa. These consist in reddening and thickening of the so-called Fliess' areas, and it is stated that at the time of labor the character of the uterine contractions may be altered by intranasal manipulations.

It has long been known that pregnancy may exert a deleterious influence upon the voice of singers, and Hofbauer has shown that it is associated with changes in the larynx which occur in three-quarters of all pregnant women. These consist in reddening and œdema of the false vocal cords, as well as of the interarytenoid region. In addition to the usual histological manifestations of inflammation, decidualike cells make their appearance in the submucosa.

Owing to the upward displacement of the diaphragm in the later months of pregnancy, it would seem as though the capacity of the lungs would be decreased. Nevertheless, Dohrn has shown that such is not the case, since the diminished height of the pleural cavities is compensated for by an increase in width. Furthermore, the investigations of Zuntz and myself upon the respiratory exchange show that, while there is no great increase in the consumption of oxygen or in the output of carbon dioxide, there is nevertheless a great increase in the amount of air inspired.

Digestive Tract.—In many instances the early months of pregnancy are complicated by minor disorders of digestion. Frequently these are not independent affections, but are to be regarded as a manifestation of a mild toxemia.

At least one-half of all pregnant women suffer from constipation. In the later months of pregnancy this may be regarded as being partly due to the pressure of the enlarged uterus, and partly to the loss of tonicity of the abdominal walls resulting from their distention.

During pregnancy the liver is in a state of unstable equilibrium, and is readily affected by various conditions, as is demonstrated by the lesions accompanying eclampsia, vomiting of pregnancy, and acute yellow atrophy of the liver, which will be discussed in detail in the chapter on the toxemias of pregnancy.

Hofbauer considers that even in normal pregnancy the liver presents characteristic changes, so that one is justified in speaking of the "liver of pregnancy." The changes consist in the appearance of fat in the cells occupying the central portion of the lobules, the disappearance of glycogen, and the dilatation of the biliary channels, the central veins, and the afferent capillaries. Opitz has cast grave doubt upon these statements, but should such changes occur as regular concomitants of pregnancy, they would offer a satisfactory explanation for several of the alterations in metabolism which characterize the condition.

Urinary Tract.—The kidneys are likewise under a considerably increased strain during pregnancy, and slight degrees of parenchymatous change are so common that they are assigned by the Germans to the "kidney of pregnancy." Such conditions are usually connected with the various disturbances of metabolism associated with the toxemias of pregnancy and will be considered under that heading, while various alterations in the constitution of the urine in normal pregnancy will be taken up in the section on general metabolism.

It was formerly believed that the ureters were sometimes compressed by the growing uterus, and under such conditions a mild infectious process, which otherwise might not give rise to symptoms, may eventuate in a pyelitis. The researches of Hofbauer, and Küstner, however, show that this is rarely the case, but that infection is favored by stasis resulting from hypertrophy of the muscle fibers of the juxta-uterine portion of the ureters. In other words, during pregnancy the lower parts of these ducts share in a muscular hypertrophy similar to that occurring in the uterus.

In the early months the bladder is more or less compressed by the growing uterus, and consequently increased frequency of micturition is often noted. As the uterus rises up into the abdominal cavity it carries with it the bladder, which then becomes an abdominal rather than a pelvic organ. Corresponding to the torsion of the uterus about its vertical axis, the bladder is pushed to the right side of the abdomen in possibly 90 per cent of all pregnant women.

Ductless Glands.—With the great increase in our knowledge concerning the functions and correlations of the endocrine glands it has gradually become recognized that all of them exert directly or indirectly a stimulating or retarding effect upon the sexual processes in women, which may become greatly exaggerated during pregnancy. Our still somewhat fragmentary knowledge upon the subject was well summarized by Blair Bell, and particularly by Seitz in his exhaustive reports to the German Gynecological Congress, in 1913, and in 1929, to which the reader is referred for information. Lange, in 1899, reported that he found the thyroid gland definitely hypertrophied in 108 out of 133 women during the last three months of pregnancy. As albuminuria was present in 18 of the women in whom no hypertrophy was noted, he naturally thought that there might be some direct relation between its absence and the urinary changes. His views were promptly taken up by numerous writers, and made the basis for a theory concerning the origin of the toxemias of pregnancy. As will be indicated in the appropriate chapter, the theory rests upon very unstable foundations, and has in great part been abandoned.

With the exception of von Graff, it is now generally believed that a moderate degree of hypertrophy of the thyroid is a usual concomitant of normal pregnancy, and may be recognized clinically in 65 to 90 per cent of all cases. Its significance is not clear, but that the thyroid plays an important part in pregnancy was shown by the experiments of Halsted, and of Ukita. The former found that when the gland was partially removed from pregnant dogs, puppies were born whose thyroids were many times the normal size, thereby indicating that they had hypertrophied in order to supplement the deficient maternal secretion. The latter states that the removal of the gland from pregnant rabbits led to prolongation of the duration of pregnancy, and to the birth of undersized and poorly developed offspring, whose thyroids were definitely hypertrophied and showed signs of increased secretory activity.

It is likewise generally admitted that the parathyroids undergo a considerable hypertrophy during pregnancy, and that their secretion is essential to its normal progress. To a great extent they act through the calcium metabolism. Insufficiency of the parathyroid secretion frequently manifests itself by the development of tetany in the mother, as will be described in the appropriate place.

As the thymus gland ordinarily atrophies with the approach of puberty it would not appear to exert any influence upon pregnancy. Bompiani, however, has shown that when it persists abnormally the organ undergoes diminution in size during pregnancy, to enlarge again after delivery. Theoretically, it is possible that the presence of a persistent thymus may have important effects upon the entire generative process.

Since Launois and Mulon, in 1904, directed attention to a hypertrophy of the hypophysis during pregnancy, a great deal of work has been done upon the subject, and the investigations of Eisemann and Stumme, Cushing, Evans and all subsequent writers have shown that the anterior lobe of the gland regularly undergoes hypertrophy during pregnancy, and returns to the usual size after its completion. The hypertrophy, which may double the size of the lobe, is due in great part to an increase in the number and size of the "Hauptzellen."

Evans holds that the anterior lobe elaborates two hormones, one having to do with growth and the other with sexual maturity, and associates the latter with the basophilic cells. In the section on the ovary, reference has been made to the observations of Smith and Engle, and of Zondek and Aschheim concerning the stimulating effect of the latter hormone upon the ovaries of immature mice, and in the present chapter it has been pointed out that its amount is so increased during pregnancy that the excess is excreted by the kidneys in such quantity that the injection of small amounts of urine into immature animals calls forth a characteristic response on the part of the ovaries, which can be utilized for the diagnosis of pregnancy. The literature upon the subject up to 1928 has been well summarized by Erhardt.

Furthermore, on account of the known relation existing between abnormalities of the hypophysis and the development of acromegaly, a similar origin has been suggested for the nonedematous thickening of the features, as well as of the extremities, which is observed in so many pregnant women.

The posterior or infundibular portion of the hypophysis does not hypertrophy during pregnancy, but, in addition to its effect upon the blood pressure, it possesses the power of markedly stimulating uterine contractions, as has been shown by Dale, Bell, and others. Abel and his coworkers have isolated from the posterior lobe a crystalline product in the form of a tartrate, which possesses an almost miraculous power of stimulating nonstriated muscle. Whether this hormone is normally concerned in the regulation of the uterine contractions at the time of labor is not known, but the researches of Knaus show clearly that susceptibility to its action increases markedly as the end of pregnancy is approached. Extracts of the posterior lobe are now marketed under various names, such as pituitrin and hypophysin, and are extensively used in obstetrical practice to stimulate inefficient uterine contractions, as well as to induce labor.

It is also definitely known that the cortex of the suprarenal bodies undergoes definite hypertrophy during pregnancy, which, according to Kolde, is most marked in the zona fasiculata. Aschner, who has considered the question in detail, emphasizes the great increase in the lipoid content of the gland, and suggests that it may be the source of the greatly increased content of such substances in the blood of pregnant women.

Skeleton and Teeth.—Rokitansky described the formation of irregularly shaped placques of porous, newly formed bone, or osteoid tissue, upon the internal surface of the cranial bones during pregnancy. These he designated as puerperal osteophytes, but neither he nor the subsequent observers, who have confirmed his findings, are clear as to their significance. Dreyfuss states that their existence may be demonstrated by the use of the x-ray in every third pregnant woman, and is inclined to believe that their production is in some way associated with the activity of the pituitary body. Hanau considers that they are most pronounced when an excessive formation of osteoid tissue occurs in other parts of the body. This he is inclined to attribute to a slight grade of osteomalacia, which he and Gelpke regard as physiological in all pregnancies, and associated with the supply of calcium salts to the fœtus.

Dibbelt estimates that throughout the second half of pregnancy at least 0.17 gram of calcium oxide must be supplied to the fœtus each day, while Bar, and Givens and Macy calculate that during the last two months the quantity must be increased to 0.64 or 0.70 gram per day. It is therefore evident, unless the pregnant woman assimilates an unusual amount of calcium from her food, that the fœtus must be supplied from her own body, and this is usually effected by partial decalcification of the bones and teeth. For that reason the teeth are prone to decay rapidly, so that the expression "for every child a tooth" has become proverbial. As a pint of milk contains 0.5 gram of calcium, it is apparent that the ingestion of a quart each day will cover the need for calcium, and will likewise serve as an efficient prophylactic.

Owing to the increased vascularity, the various pelvic joints become more succulent and permit greater mobility. Occasionally they become so relaxed that locomotion is seriously interfered with. The treatment of this abnormality will be considered in the chapter upon the pathology of pregnancy.

Nervous System.—Various disturbances of the nervous system occur during pregnancy, but as they are distinctly abnormal they will be considered later. On the other hand, mild degrees of disturbed mental equilibrium are so frequently observed as to be considered almost physiological. In this category may be placed the longings and cravings for unusual or abnormal articles of diet. Many women also experience pronounced changes in disposition, and not a few multiparous patients recognize the occurrence of pregnancy by their appearance. Again, in those of neuropathic tendencies the mental equilibrium may be overthrown to a greater or less degree, the patient becoming excitable, morbid, or morose, and in rare instances developing a true psychosis.

Skin.—Reference has already been made to the formation of striæ and to the pigmentation of the nipple and areola. In other cases the linea alba becomes markedly pigmented. Occasionally irregularly shaped, yellowish patches of varying size appear on the face and neck, the condition being known as *cloasma,* which fortunately usually disappears after delivery. Very little is known concerning the nature of these conditions, but Wychgel has demonstrated that the pigment deposited in the papillary layer of the skin responds to the usual tests for iron. He considers that it is derived from the hemoglobin of the maternal blood cells which have succumbed in the fight against the fœtal tissues.

Reticulo-endothelial System.—In recent years, the endothelial cells, the Küpfer cells of the liver, and connective-tissue and wandering cells in various parts of the body have been grouped together under this name, and are supposed to play a prominent part in the destruction of bacteria and the combating of infection. Benda, Lundwall and others have attempted to study its functions experimentally in pregnant women, and believe that they are considerably augmented, but as yet their findings are too uncertain to be of great clinical value.

General Metabolism.—Generally speaking, gestation is characterized by improved health. In some instances the improvement in nutrition is noted shortly after conception, but it may not become manifest for several months. For this reason it is frequently possible to distinguish two periods in pregnancy. The earlier is characterized by lassitude, mental depression, and some loss of weight, while the latter is conspicuous for an excellent condition of body and mind.

Analogous conditions have been observed in pregnant dogs, rabbits, and guinea-pigs by Hagemann, Ver Eecke, Jägeroos, Bar, and Murlin. Those interested in the subject are referred particularly to the monumental metabolic studies of Bar, which clearly show that in animals catabolic processes are most prominent in the first half of pregnancy, as is indicated by the fact that more material is excreted than ingested, whereas the reverse obtains in the second half. During the latter period there is a marked tendency toward storage of the various food stuffs. As was shown by Bar in pregnant dogs, this storage, particularly of proteids, is more than sufficient for the needs of the fœtuses and their appendages, so that in the healthy animal the second half of pregnancy may be regarded as a period of gain, and not as a sacrifice of the individual for the sake of the species.

Metabolic studies show that women in the weeks immediately preceding delivery possess an unusual capacity for storing up the essential elements of their diet, and that their metabolism is analogous to that observed in animals in the corresponding period of pregnancy. In 1862, Gassner studied the changes in weight during the last three months, and found an average monthly increase of from 3½ to 5½ pounds. The gain was proportional to the weight of the individual, and was relatively larger in multigravidæ. Moreover, he considered that the absence of such a gain in weight was indicative of the death of the fœtus *in utero*. Confirmatory results were obtained by Zangemeister in 1916, who found that a daily increase averaging 55 grams occurs during the last months of pregnancy. Moreover, he noted that the gain continues up to the last few days of pregnancy, but that three or four days before the onset of labor, a loss of 1000 grams in weight occurs. Accordingly, if normal patients are weighed daily before breakfast, the imminence of labor may be predicted whenever the usual gain is replaced by a loss in weight. On the other hand, he showed that an excessive gain in weight is abnormal, and in many instances enables one to detect the presence of occult œdema, before visible swelling and pitting of the skin occur.

The daily output of urine is subject to so many variations, being influenced by climatic, dietetic, and individual peculiarities, that it is difficult to fix a normal standard. Ordinarily, it varies between 1000 and 1500 cubic centimeters, though smaller or larger amounts may be excreted without necessarily indicating a pathological condition. Of particular interest, though, is the ratio which the volume of the urine bears to the fluid intake. In three normal pregnancies my former associate, J. M. Slemons, found that during the days immediately preceding delivery it represented from one-half to three-quarters of the fluid taken by the mouth, whereas in a patient with dead twins it amounted to 93 per cent, which is approximately the normal nonpregnant ratio.

Proteid metabolism in the later months of pregnancy has been studied by Zacharjewsky, Schrader, Hahl, Hoffström, Hoogenhuyse, as well as in my clinic, and shows that considerable quantities of nitrogen are retained when the woman is allowed an adequate diet. The average daily nitrogenous exchange in three women studied by Slemons is given in the accompanying table.

Type	Fluid Ingested	Quantity of Urine	Nitrogen in Food	Nitrogen in Urine	Nitrogen in Fæces	Nitrogen Balance
Primigravida	1780 c. c.	1306 c. c.	13.80 gms.	12.43 gms.	0.95 gm.	+ 0.42
Multigravida	1890 c. c.	1007 c. c.	16.77 gms.	13.26 gms.	0.53 gm.	+ 2.98
Twin pregnancy	2354 c. c.	1135 c. c.	15.00 gms.	8.28 gms.	2.00 gms.	+ 4.72

Such a storage of nitrogen as shown by these figures would indicate a considerable construction of proteid tissue, and corresponds to the growth of the fœtus, placenta, uterus, and the maternal organism in general.

As to the period of pregnancy at which the maternal organism first acquires the power of storing nitrogen, it is impossible to make definite statements. In one of my patients, studied by Karl M. Wilson, daily observations upon the nitrogen exchange from the tenth to the fourteenth week of pregnancy, revealed a considerable capacity for storing nitrogen, and even at that early period the total storage for the four weeks amounted to 59.99 grams. As it is evident that this amount was greatly in excess of the needs of the developing ovum, it must be assumed that the bulk of it was added to the general maternal organism, possibly as a reserve to be drawn upon later, when the needs of the embryo become greater.

In a patient studied by Hoffström for the last twenty-four weeks of pregnancy, storage of nitrogen was observed throughout the entire period. This averaged 1.84 gram per day, so that the total amount stored amounted to 310 grams; the most marked storage occurring from the twenty-ninth week onward, when the needs of the growing fœtus were at a maximum. He estimated that 101 grams of this amount were needed for the development of the fœtus, whereas the balance must have been added to the general maternal organism. He calculated that approximately 51 grams of this balance were utilized in the development of the uterus and breasts, leaving 158 grams to be added to the maternal nitrogen capital, although it was impossible to make a definite statement as to the exact manner in which it was stored. Furthermore, similar results were obtained in two patients studied in my clinic, in 1915, by Wilson during the last nineteen and fifteen weeks of their respective pregnancies.

It would therefore appear that in healthy women the ability to store nitrogen is acquired at a comparatively early period of pregnancy. Moreover, this capacity for storage increases as pregnancy advances and as the needs of the fœtus become greater. As the amount stored is far in excess of the needs of the fœtus, a considerable quantity of "reserve" nitrogen must be added to the maternal organism, which can be drawn upon, and possibly entirely exhausted, during labor and the puerperium.

In patients suffering from gastro-intestinal disturbances, which so frequently accompany early pregnancy, it is probable that storage of nitrogen does not begin until the symptoms have subsided; as it is frequently noted that such patients lose considerably in weight during the continuance of the attack. In general, however, it may be assumed that pregnancy is not necessarily a period of sacrifice on the part of the individual, but may actually be one of gain.

The distribution of the various protein fractions of the blood during pregnancy has been studied by Eufinger, Plass and his coworkers, and by Eastman in this Clinic. Eufinger found a relative decrease in total proteins, which is associated with a progressive increase in fibrinogen, globulin and euglobulin, but with a marked decrease in albumin. Eastman is unable to substantiate these findings, although he found a decrease in total protein associated with a very slight relative increase in globulin and practically no change in the albumin-globulin ratio. He believes that the changes in the stability of the plasma during gestation are the result of an increase in fibrin rather than of an alteration in the amount of serum albumin or globulin. Plass regards the decrease of plasma protein as due to true dilution. Schmidt, Bickenbach and Jonen have recently found that in the dog pregnancy is associated with a definite increase in fibrinogen in the whole blood as well as in the plasma. This agrees with the work of Plass, Kraul and Müller, and Dienst in women.

According to the work of Folin, de Wesselow, Hellmuth, Plass, Stander, Harding and others, the noncoagulable, or nonprotein nitrogen of the blood during pregnancy is essentially the same as in the normal nonpregnant woman, or it may be slightly decreased. Some of these investigators have found that the ratio of the urea nitrogen to nonprotein nitrogen is lowered. Although Runge and Juhl, and others report an increase in the amino-acid nitrogen, Hellmuth and Schlossman are convinced that no change occurs during pregnancy. Stander states that normal gestation is not associated with marked alterations in the amount of creatinine, creatine or uric acid in the blood.

As a result of the alterations in protein metabolism accompanying normal gestation, it is reasonable to expect some change in the amount of nitrogen excreted by the mother, and Zacharjewsky, in 1894, showed that the quantity of nitrogen excreted in the urine was diminished. Murlin, Bar, and Stander, upon studying the distribution of the several nitrogen fractions in the urine found that less urea was excreted than in the nonpregnant woman. Furthermore, this is usually accompanied by an increase in the percentage of undetermined nitrogen; a part of which, according to Falk and Hesky, is accounted for by an increased elimination of amino-acids and peptid nitrogen. It is of interest to note that creatine makes its appearance in the urine during the latter part of pregnancy, as shown by Krause and Cramer, and others.

Carbohydrate Metabolism.—Pregnancy is often accompanied by a glycosuria, which, according to Nürnberger, is probably due to a lowering of the renal threshold for glucose, or perhaps to increased activity of the pituitary gland as suggested by Wallace and Bose. The work of Benthin, Morris, Stander, and Hellmuth shows that the blood sugar during pregnancy is not elevated, and some of these workers even report values slightly below normal.

The usual relationship between carbohydrate and fat seems to be disturbed during pregnancy. According to Porges and Novak, a diet poor in carbohydrates leads to acetonuria in normal pregnancy, which does not occur in nonpregnant women upon the same diet. Moreover, Bokelmann and Bock have shown that acetone bodies are increased in the blood of normal pregnant women.

Fat Metabolism.—Normal gestation is associated with an increase in neutral fat, as well as in lipoids, as Slemons and Stander found that the fat content of the maternal blood is much greater in pregnant than in nonpregnant women, being 900 and 600 milligrams per 100 cubic centimeters, respectively. They also noted an increase in lecithin and cholesterol, and regard this, as well as the increase in total neutral fat, as a preparation for lactation. Their work has been corroborated by Tyler and Underhill, as well as by Hellmuth and others.

Mineral Exchange.—There must be a considerable drain on the mother so far as calcium and phosphorus are concerned, since Camerer and Soldner have shown a preponderance of these two elements in the ash of the human fœtus, and von Oettingen has noted a higher concentration in the fœtal blood. A slight decrease in calcium in the maternal blood has been noted by Bock, Plass and Bogert, Krebs and Briggs, and by Stander, Duncan and Sisson in this clinic. On the other hand, several observers could demonstrate no change, but the preponderance of evidence points to a very slight decrease in the calcium, but to no change in the phosphorus content of the mother's blood.

Harding has collected figures from various authors, and concludes that sodium diminishes in the serum, but increases in the corpuscles of the maternal blood. Stander so far has been unable to detect such changes, but he is again studying the problem. Potassium, magnesium, chlorine, and inorganic sulphur appear to undergo no change in the blood of normal pregnant women.

The fœtus requires iron for building its own hemoglobin and nucleoproteins, and probably gets it in large part from the maternal hemoglobin. It undoubtedly takes up iron directly from degenerated maternal red blood cells through the syncytial covering of the chorionic villi, as can be readily demonstrated in the placenta of the dog and less satisfactorily in that of women. Charrin states that the reserve iron in the maternal spleen is diminished during gestation.

Acid-Base Equilibrium.—The alveolar CO_2 tension is definitely lowered during pregnancy, as was first shown by Hasselbalch and subsequently confirmed by many workers. The carbon dioxide combining power of the blood is similarly decreased, and at term it is approximately 45 volumes per cent, as compared with about 65 volumes per cent in nonpregnant women. This reduction in alkali reserve has been confirmed by numerous investigators, and has led to the assumption that an "acidosis" exists during normal pregnancy. On the other hand, recent work on the total serum electrolytes by Oard and Peters, as well as by Stander, Eastman, Harrison and Cadden in our service, has shown that the phrase is a misnomer, since normal pregnancy is not associated with an acidosis nor with an accumulation of abnormal acids. Stander and his associates found that normal gestation is accompanied by a decrease in alkali reserve, as well as by a reduction in total base, amounting to 5 per cent, and regard such a finding as a remarkable departure from the normal. They further observed a reduction in the anions,—serum protein and serum bicarbonate. These changes, however, do not affect the hydrogen-ion concentration (P_H) of the blood, which remains unaltered at about 7.40. Consequently, with a normal blood P_H, with no increase in organic acids nor with any accumulation of abnormal acids in the blood, associated with the reduction in the bicarbonate or alkali reserve, it would appear that in normal pregnancy we have to deal with a normal acid-base balance, or with a tendency towards a compensated alkali deficit, rather than with an acidosis.

Basal Metabolism.—In 1904, Magnus-Levy stated that the oxygen absorption was 17 per cent higher in the eighth than in the third month of pregnancy. Since then the basal metabolic rate during pregnancy has been carefully studied by numerous investigators, notably Hasselbalch, Carpenter and Murlin, Baer, Sandiford and Wheeler, as well as by Stander and Peckham in our clinic. The general consensus of opinion is that a definite elevation in the basal metabolic rate occurs in the latter half of pregnancy. Stander and Peckham found an average elevation of plus 4.5 in normal pregnant women just before delivery, which returns to normal at about the tenth day of the puerperium. They attribute the increase to the growing product of conception, and possibly to a slightly increased activity of the thyroid gland.

The more we learn concerning the metabolism of normal pregnancy, the more are we impressed with the fact that the maternal organism in the second half of gestation preserves the strictest economy in its metabolic processes. Its purpose, of course, is to facilitate the upbuilding of the fœtus without too great strain upon the mother, but we are as yet entirely ignorant of the mechanism by which such changes are rendered possible.

	Nonpregnant	Pregnant at Term
Urine		
Total nitrogen in grams per 24 hours......	12-16	8-12
Urea-nitrogen as percentage of total nitrogen	80-90	70-85
Ammonia-nitrogen as percentage of total nitrogen	2.5-4.5	3-5
Blood		
N. P. N.	32.0 mgs. per 100 c.c.	28.0
Urea-nitrogen	18.5 “ “ “ “	12.5
Uric acid	3.0 “ “ “ “	3.0
Creatinine	1 to 2 “ “ “ “	1 to 2
Chlorides	526.0 “ “ “ “	494.0
Sugar	80.0 “ “ “ “	80.0
CO_2 combining power	60.0 volumes per cent	48.0
P_H	7.4	7.4
Total base	164.0 mm.	157.0
Total proteins (serum)	7.4 gms. per 100 c.c.	6.5

The table at the foot of page 217, prepared by Stander, shows the average chemical findings in the urine and blood of normal nonpregnant and of pregnant women, and affords a convenient means of comparing them.

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CHAPTER VII

DIAGNOSIS OF PREGNANCY—DURATION OF PREGNANCY—ESTIMATION OF DATE OF CONFINEMENT

Ordinarily, the diagnosis of pregnancy offers little or no difficulty, and the patient is usually aware of the true condition before she consults a physician. In a small minority of cases, however, the task is by no means easy, and despite every known method at our command we are occasionally unable to decide with certainty.

Mistakes in diagnosis are most frequently made in the first few months, while the uterus is still a pelvic organ; although it is by no means impossible to confound a pregnancy, even at full term, with a tumor of some other nature. Such errors are usually the result of hasty or imperfect examination, but a false conclusion may sometimes be arrived at, even after the most conscientious exploration of the patient. Some idea of the frequency of such mistakes may be realized when it is stated that there is hardly a gynecologist of experience who has not opened the abdomen on one or more occasions, with the expectation of removing a tumor of the uterus or its appendages, and has been surprised to find himself in the presence of a normal pregnancy.

It is often a matter of considerable importance that a diagnosis be made in the early months of pregnancy; but, unfortunately, it is just at this period that our diagnostic ability is most restricted, as the absolutely positive signs do not, as a rule, become available until the fifth month. Hence, it follows that in cases in which the existence of such a condition might affect the reputation or interests of the patient a positive expression of opinion should be deferred until the diagnosis is beyond all doubt.

The diagnosis is based upon the presence of certain symptoms and signs. The former are chiefly subjective and are appreciated by the patient; while the latter are made out by the physician after a careful physical examination, in which the senses of sight, hearing, and touch, as well as certain laboratory procedures, are employed.

The signs and symptoms are usually classified into three groups: the positive signs, which cannot usually be detected until after the fourth month; the probable signs, which can be appreciated at an earlier period; and the presumptive evidences, which are usually subjective in character, and may be experienced at varying periods.

Positive Signs of Pregnancy.—These are four in number, and consist in (1) hearing and counting the fœtal heart beat, (2) ability to palpate the outlines of the fœtus, (3) perception of its active and passive movements, and

(4) recognition of the fœtal skeleton by means of the röntgen ray; and when any one of them is obtained the diagnosis is established beyond all doubt.

The Fœtal Heart Beat.—Whenever one can hear and count the pulsations of the fœtal heart, the diagnosis of pregnancy is assured beyond peradventure; unfortunately, this sign cannot usually be appreciated until the eighteenth or twentieth week, though not a few writers claim that it may be possible as early as the twelfth or fourteenth week.

The fœtal heart was first heard by Mayor, of Geneva, in 1818, but was recognized independently by Lejumeau de Kegaradec, in 1821, to whom we are indebted for our fundamental information upon the subject; indeed, so complete was his monograph that subsequent investigations have revealed but little with which he was not familiar. He made his discovery quite accidentally, while attempting to hear the sounds which he supposed would be made by the fœtus splashing in the liquor amnii. On auscultating the abdomen of a pregnant woman through her clothing, including the corset, he heard a double sound, which varied in frequency from 143 to 148 beats to the minute, and closely resembled the ticking of a watch under a pillow. He concluded that it could be produced only by the fœtal heart, as the pulse of the mother did not exceed 70. For further details concerning the history and earlier work upon the subject, the reader is referred to the works of Kegaradec, Kennedy, Depaul, and Montgomery.

The fœtal heart beat, after the eighteenth or twentieth week of pregnancy, should be detected without difficulty. Ordinarily it varies in frequency from 120 to 140 beats to the minute, and is a double sound, closely resembling the tick of a watch under a pillow. In order to hear it the abdomen should be bared, or at most covered by a thin cloth. In the earlier months it is best detected by means of a stethoscope, but at a later period the direct application of the ear gives more satisfactory results. One should not be content with merely hearing the fœtal heart, but should always attempt to count its rate and compare it with that of the maternal pulse.

In the early months the heart should be sought just over the symphysis pubis; but in the later months the situation at which it is best heard varies according to the position and presentation of the fœtus, details concerning which will be given when we consider the methods of obstetrical examination.

The rate of the fœtal heart is subject to considerable variations, which afford us a fairly reliable means of judging as to the well-being of the child at the time of labor. As a general rule, its life should be considered in danger when the heart beats fall below 100 or exceed 160. Following Frankenhäuser's publication in 1859, various writers have stated that there is a marked difference in the rapidity of the heart beat in the two sexes, and that a rate of 124 or less indicates a boy, and 144 or more a girl. Subsequent investigation, however, has failed to confirm their conclusions, as a positive diagnosis can be made by this means in only about 50 per cent of the cases. Indeed, there is no method by which the sex can be definitely determined before birth, except occasionally in breech presentations, when the genitalia can be differentiated by the examining finger.

In women possessing very thin abdominal and uterine walls the impulse of the fœtal heart may occasionally be appreciated by direct palpation, especially when the child is lying in the right mento-iliac position. Such observations have been reported by Fischel, Duval, and others.

Other Sounds Which May Be Heard on Auscultation.—In addition to hearing the fœtal heart, auscultation of the abdomen in the later months of pregnancy often reveals other sounds, the most important of which are the funic souffle, the uterine or placental souffle, sounds due to movements of the fœtus, the maternal pulse, and the gurgling of gas in the intestines of the mother.

The *funic souffle* is a sharp, whistling sound, synchronous with the fœtal pulse, which can be heard in about 15 per cent of all cases. It is very inconstant in its appearance, as it may be recognized distinctly at one examination and be absent on succeeding occasions. It was first described by Evory Kennedy, who supposed that it was due to some interference with the circulation of the blood through the umbilical arteries, and subsequent investigations have served to confirm his conclusions. Its mode of production may occasionally be demonstrated in very thin women, in whom the umbilical cord may be palpated between the body of the child and the uterine wall, and on making pressure upon it with the stethoscope a distinct souffle can occasionally be elicited. This is not, however, a sign of very great importance, although, when heard, it is distinctly characteristic of pregnancy.

The *uterine souffle* is a soft, blowing sound, synchronous with the maternal pulse, and is usually most distinctly heard upon auscultating the lower portion of the uterus. It is due to the passage of blood through the dilated uterine vessels. This sound was first described by Kegaradec, who considered that it was produced by the circulation of the blood through the placenta. He therefore designated it as the *placental souffle,* and believed that it was of value in determining the situation of that organ. Subsequent investigations, however, have shown that such is not the case, and that the sound originates as I have indicated. As stated by Rotter and others, it may occasionally be appreciated by the palpating finger. This sign is not characteristic of pregnancy, as it may be present in any condition in which the blood supply to the genitalia becomes markedly increased, and accordingly may be heard in nonpregnant women presenting tumors of the uterus or ovaries.

Certain *movements of the fœtus* may likewise be recognized on auscultation. According to Ahlfeld, it is impossible to hear the movements of the extremities, but he considers that the sounds which are usually so interpreted are produced by spasmodic contractions of the diaphragm, and are analogous to singultus.

The *maternal pulse* can frequently be distinctly heard on auscultating the abdomen, and in some instances the pulsation of the aorta is so violent as to communicate a distinct throb to the ear. Occasionally, in neurotic women, the pulse may become so rapid during examination as to mask the fœtal heart sounds.

In addition to the sounds just mentioned, it is not unusual to hear certain others produced by the passage of gases or fluids through the intestines of the mother.

Mapping Out the Outlines of the Fœtus.—In the second half of pregnancy it is possible to distinguish the outlines of the fœtus by palpation through the abdominal walls, and this becomes easier the nearer term is approached. When it is desired to map out the fœtus the examination should be made in a methodical manner, following the rules which will be given later.

A diagnosis of pregnancy should not be made from this sign alone, unless one is able to feel distinctly the various portions of the fœtus and to distinguish its head, breech, back, and extremities. Subserous myomata occasionally simulate the head or small parts, or both, and may occasionally give rise to serious diagnostic errors.

Movements of the Fœtus.—The third positive sign of pregnancy is present whenever the physician is able to feel the spontaneous movements of the fœtus.

After the fifth month the *active movements* may be felt at intervals on placing the hand over the abdomen. These vary from a faint flutter in the early months to quite violent motions at a later period, which are sometimes visible as well. Occasionally, somewhat similar sensations may be produced by contractions of the intestines or the muscles of the abdominal wall, though these should not deceive an experienced observer.

The *passive movements,* obtained by *ballottement,* consist in the rebound of a fœtal extremity when displaced from its position by the examining finger, whereby a sensation is afforded similar to that produced when a sudden motion is given to a piece of ice in a glass of water, so that at first it sinks and then slowly comes back to the finger. This sign is available from the early part of the fourth month, and may be obtained through either the vagina or the abdominal walls. To obtain vaginal ballottement the patient should be on her back; the physician then introduces two fingers into the vagina and carries them up to the anterior fornix, to which he imparts a sudden motion with his finger-tips, afterwards retaining them in the same position. After a moment the extremity of the child, which occupies the lower segment of the uterus, usually the head, drops down upon them again.

External ballottement can be obtained by imparting a sudden motion to the portion of the abdominal wall covering the uterus; in a few seconds the rebound of one of the extremities or of the head of the fœtus can be felt. This sign, while not absolutely positive, is of very considerable value, as it can be simulated only by a pedunculated tumor swimming in ascitic fluid.

The X-Ray.—Whenever the outlines of the fœtal skeleton can be distinguished by means of the röntgen ray, the existence of pregnancy is assured. Unfortunately, like the other positive signs, this method of diagnosis is not available until the second half of pregnancy. By its means Bartholomew, Sale and Calloway were able to make a positive diagnosis in one-third of their patients at the fifth month, in one half at the sixth month, and almost constantly later. In my experience, the method is of especial value in differentiating the pregnant uterus from abdominal tumors of other origin, particularly when the child is dead; as well as for establishing the diagnosis when multiple pregnancy is suspected, and for detecting the presence of such fœtal abnormalities as hydrocephalus and anencephalus.

Peterson claims that the employment of the x-ray in association with artificial pneumoperitoneum permits a positive diagnosis as early as the sixth or eighth week. In this event, the decision is not based upon the recognition of fœtal bones, but rather upon the detection of changes in the lower uterine segment. These changes consist in an enlargement of the isthmus of the uterus in its long axis, together with a lateral widening. I have had no experience with the method, but, in view of Peterson's well-known conservatism, I am prepared to accept his statements.

Probable Signs of Pregnancy.—These consist in (1) enlargement of the abdomen; (2) changes in the shape, size and consistence of the uterus; (3) changes in the cervix; and (4) the detection of intermittent contractions of the uterus.

Enlargement of the Abdomen.—From the third month onward the uterus can be felt through the abdominal walls as a tumor, which gradually increases in size up to the end of pregnancy. Generally speaking, any enlargement of the abdomen during the childbearing period should be regarded as *prima facie* evidence of the existence of pregnancy. Figures 196-199 give a good idea of the changes in the shape of the abdomen at the various months.

The abdominal enlargement is less pronounced in primiparæ than in multiparæ, for the reason that in the latter the abdominal walls have lost a great part of their tonicity and are sometimes so flaccid that they afford little or no support to the uterus, which then sags forward and downward, giving rise to a *pendulous abdomen.* This difference is so apparent that it is not unusual for women in the latter part of a second pregnancy to suspect the existence of twins from the increased size of the abdomen, as compared with that noted in the corresponding month of the previous pregnancy. It should also be borne in mind that the abdomen changes its shape materially according as the woman is in the upright or horizontal position, being much less prominent when she is lying down. (See Fig. 187.)

Changes in Size, Shape, and Consistence of Uterus.—In the first three months these are the only physical signs available, and *the existence of an enlarged uterus at any time during the childbearing period should be regarded as presumptive evidence of pregnancy, until such a possibility has been conclusively eliminated.*

During the first few weeks the increase in size is limited almost entirely to the anteroposterior diameter; but at a little later period the body of the uterus becomes almost globular in shape, and at the third month attains the size of an orange. During the first two months the pregnant uterus still continues to be entirely a pelvic organ, whereas during the third month it begins to rise above the symphysis. At the same time the angle between the body and cervix becomes accentuated—in other words, the physiological anteflexion is increased.

More characteristic than the changes in shape are those affecting its consistence. On bimanual examination the uterine body offers a doughy or elastic sensation, and in many instances becomes so soft as to be hardly distinguishable. Dickinson has pointed out that these changes can be noted at a very early period.

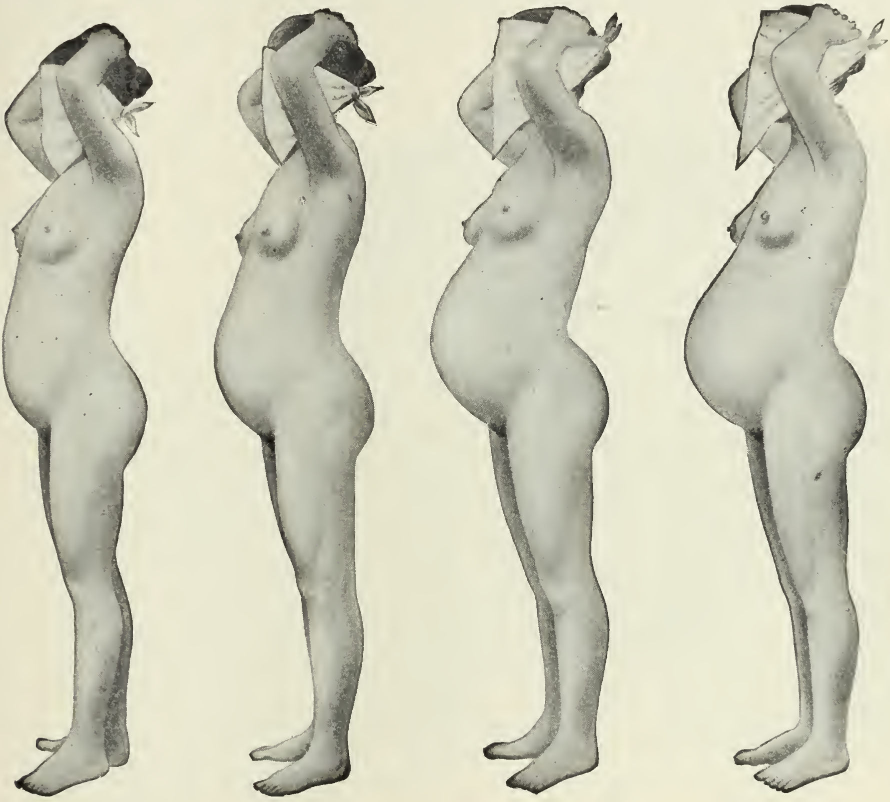

Fig. 196. Fig. 197. Fig. 198. Fig. 199.

Figs. 196-199.—Showing Relative Abdominal Enlargement at Third, Sixth, Ninth, and Tenth Month of Pregnancy.

According to R. von Braun, it would appear that as early as the first week evidence of pregnancy is afforded by the appearance of a more or less longitudinal furrow upon either the anterior or posterior surface of the uterus. Its presence he attributes to changes in consistence and the alternation between contraction and relaxation of the portion of the organ in which the ovum is situated.

At about the sixth week another sign of very considerable value—the so-called *Hegar's sign*—becomes available. On careful examination with one hand upon the abdomen and two fingers of the other hand in the vagina, the firm, hard cervix is felt, and above it the elastic body of the uterus, while between the two the isthmus is felt as a soft compressible area. Occasionally the change in consistence in this location is so marked that no connection between the cervix and body appears to exist, so that inexperienced observers may mistake the cervix for a small uterus, and the softened body for a tumor of the tubes or ovaries.

The value of this sign, which was first described in 1884, by Reinl, one of Hegar's assistants, is universally admitted, and I consider it the most valuable sign of early pregnancy. Its production probably depends upon forcing the portion of the ovum occupying the lower uterine segment into the upper part of the body of the uterus, so that the empty and softened isthmus can then be readily compressed between the fingers. Figure 201 gives a good idea of how the sensation is to be obtained on bimanual examination; and Figures 202 and 203 show the softened condition of the uterus which makes it possible. This sign is not, however, absolutely characteristic or dependable, as it may occasionally be elicited when the walls of the nonpregnant uterus are unduly soft.

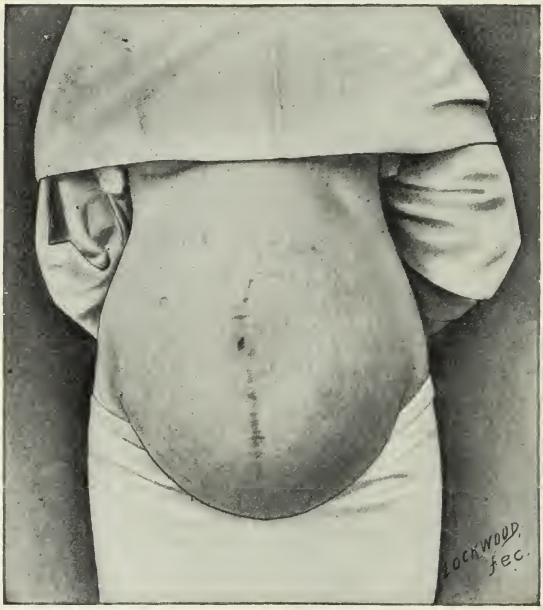

Fig. 200.—Pendulous Abdomen in a Multiparous Woman with Normal Pelvis.

Macdonald, in 1908, directed attention to a modification of Hegar's sign, which he claims will make possible the diagnosis of pregnancy during the course of the first month. It is based upon the exaggerated flexibility of the isthmus of the uterus, and is manifested by the unusual ease with which the fundus and cervix can be brought together on vaginal manipulation.

Cervix.—Beginning with the second month of pregnancy, the cervix becomes considerably softened, and in primiparous women the os externum offers to the finger a sensation similar to that obtained by pressing upon the more yielding lips instead of the harder cartilage of the nose, as at other times. Occasionally, however, the softening does not occur until much later in pregnancy, and in certain inflammatory conditions, as well as in carcinoma, the cervix may remain firm and hard until the onset of labor. Moreover, as pregnancy advances, the cervical canal becomes so patulous that it frequently admits the tip of the finger, which in extreme cases can be introduced through the internal os.

Intermittent Contractions of the Uterus.—From the first weeks on, at intervals of from three to ten minutes, the pregnant uterus undergoes painless contractions, which in the early months can be appreciated by bimanual examination, and later by the hand upon the abdomen, when the previously relaxed organ is felt to become firm and hard, remaining so for a few moments, and then returning to its original condition. Attention was first called to this phenomenon by Braxton Hicks, and the sign has since been known by his name. It is not, however, infallible, as Ko Chi Sun demonstrated in this clinic that the human uterus, whether pregnant or not, is constantly undergoing rapid rhythmic contractions. By appropriate methods it can be shown that strips of uterine muscle suspended in oxygenated Locke's fluid possess this property from the latter part of intra-uterine life until some time after completion of the menopause. Moreover, movements simulating Braxton Hicks' contractions are sometimes observed in hematometra, and occasionally in cases of soft myomata.

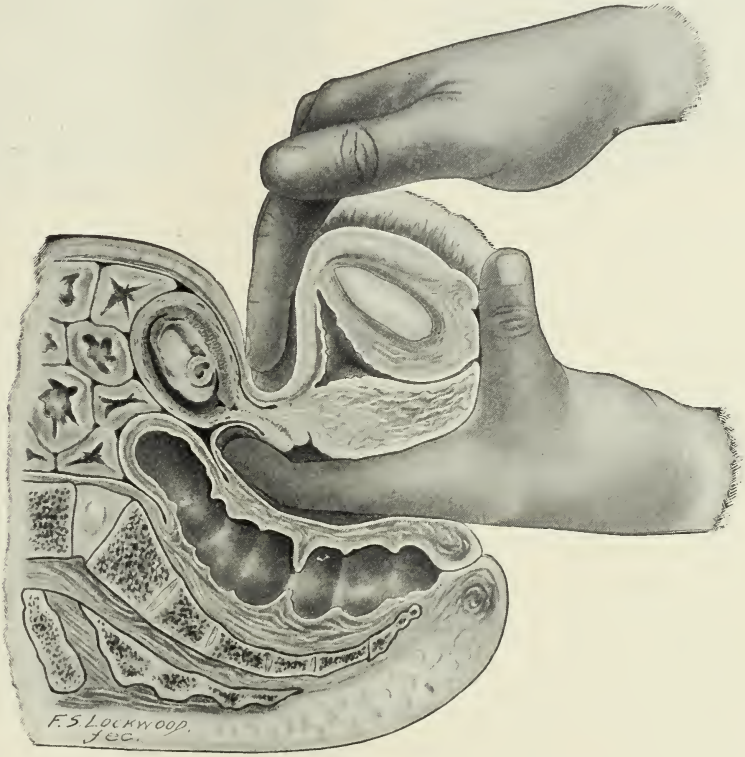

Fig. 201.—Method of Detecting Hegar's Sign.

Whenever one or several of these probable signs of pregnancy are detected the evidence becomes very strong. Nevertheless, if there is any possibility of wronging our patient we are not justified in making a positive assertion, even though we may feel morally sure of our diagnosis, until the positive signs become available.

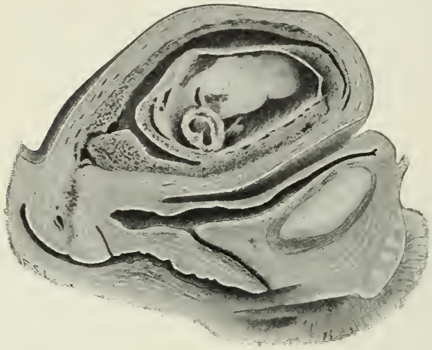

Fig. 202.—Ten Weeks' Pregnant Uterus (Pinard). × ½.

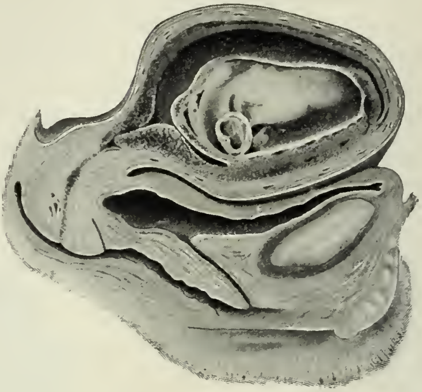

Fig. 203.—Showing Mode of Production of Hegar's Sign.

Presumptive Signs of Pregnancy.—The presumptive evidences of pregnancy are afforded in great part by subjective symptoms, which may be appreciated by the patient herself. These consist in (1) cessation of the menses, (2) changes in the breasts, (3) morning sickness, (4) quickening, (5) discoloration of the mucous membranes, (6) abnormalities in pigmentation, (7) disturbances in urination, (8) mental and emotional changes, (9) diminished tolerance for sugar, and (10) various changes in the blood serum and urine.

Cessation of the Menses.—Most important is the cessation of the menstrual flow. In women exposed to the possibility of pregnancy, and whose menses have previously been regular, a sudden cessation is a most characteristic sign; and from it alone the majority of married women do not hesitate to diagnosticate their condition. But in patients presenting an irregular menstrual history this symptom does not possess the same diagnostic value, as we know that certain diseases may give rise to amenorrhea of many months' duration, in the course of which conception occasionally occurs.

Furthermore, a single menstrual period may be missed by women who fear the possibility of pregnancy. On the other hand, false statements are often made, and a patient who has missed one or more periods may complain of profuse uterine hemorrhage, in the hope of misleading the physician and inducing him to curet the uterus.

In not a few instances menstruation may appear once after the commencement of pregnancy, though the flow is usually less profuse than at other times. In many of these cases it is probable that conception has occurred shortly before the period. A plausible explanation for such an occurrence may possibly be afforded by the as yet unpublished "placental sign" of Carl Hartman of the Carnegie Laboratory of Embryology. He states that the great majority of pregnant monkeys show slight vaginal bleeding fifteen to thirty-seven days after fertilization, which he attributes to the invasion of maternal vessels in the early stages of placental formation, and it is quite possible that a similar phenomenon may occur in women. Only very rarely, however, does the menstrual flow appear more than once, and, although its regular recurrence is theoretically possible until the decidua vera and capsularis fuse together at the fourth month, yet repeated bleeding should always arouse suspicion as to the existence of disease of the endometrium, placenta previa, or some other pathological condition.

One occasionally hears of women who menstruate regularly throughout pregnancy, but the majority of such accounts are apocryphal, or else the condition is associated with uterine disease.

Changes in the Breasts.—In the chapter upon the Physiology of Pregnancy reference was made to the changes which occur in the breasts. Generally speaking, in primiparæ these are quite characteristic, but are of less value in multiparæ, since the breasts of the latter not infrequently contain a small amount of milk or colostrum for months, or even for years, following the last labor. Occasionally, changes in the breasts similar to those produced by pregnancy may be observed in women suffering with ovarian or uterine tumors. Nor is the possibility of their occurrence excluded in instances of spurious or imaginary pregnancy.

Nausea and Vomiting.—The establishment of pregnancy is frequently manifested by disturbances of the digestive system, more particularly manifested by nausea and vomiting. This *"morning sickness,"* as the name implies, usually comes on in the earlier part of the day, and passes off in a few hours, although it occasionally persists longer or may occur at other times. It usually appears about the end of the first month, and disappears spontaneously six or eight weeks later, although some patients suffer from it for a longer period.

Occasionally, similar symptoms result from nervousness or from the fear of an illegitimate pregnancy, as well as in certain cases of pseudocyesis. It is generally believed that these symptoms are observed in most pregnant women, but, upon analyzing the records of my private patients, I found that slightly less than one-half of them suffered from any form of vomiting. In many it amounts to nothing more than an occasional sensation of nausea; others vomit considerably, while in rare instances the vomiting may be so persistent as to interfere seriously with nutrition. It is then designated as pernicious vomiting, which will be considered in detail in Chapter XXVI.

Quickening.—About the eighteenth or twentieth week the woman becomes conscious of slight, fluttering movements in her abdomen, which gradually increase in intensity. These are usually due to movements of the fœtus, and their first appearance is designated as "quickening" or the perception of life. Occasionally fœtal movements may be perceived as early as the tenth week, while in rare instances they are not experienced at all.

This sign offers only corroborative evidence of pregnancy, and is of no value unless confirmed by the hand of the physician, as in many nervous women similar sensations are experienced in its absence.

Discoloration of the Mucous Membrane of Vagina and Vulva.—Under the influence of pregnancy the mucosa about the vaginal opening and the lower portion of the anterior vaginal wall frequently take on a dark bluish or purplish, congested appearance. Attention was first called to this condition by Jacquemier and Kluge, but particular stress was laid upon its significance by James R. Chadwick, of Boston, so that in America it is known as *Chadwick's sign.* Its presence supplies valuable presumptive evidence, but is not conclusive, as it may likewise be observed in any condition leading to intense congestion of the pelvic organs.

Pigmentation of the Skin and Abdominal Striæ.—These manifestations, which have already been referred to in the chapter upon the physiology of pregnancy, are usually observed in pregnant women, but are not characteristic, as they are sometimes lacking, and, on the other hand, may be associated with tumors of other origin.

Urinary Disturbances.—In the early weeks of pregnancy the enlarging uterus, by exerting pressure on the bladder, may cause a desire for frequent micturition. This continues for the first few months, and gradually passes off as the uterus rises up into the abdomen, to reappear when the head descends into the pelvis a few weeks before term.

Cravings—Mental and Emotional Changes.—Occasionally the appetite of the pregnant woman becomes very capricious, and she may evince an almost unconquerable desire for peculiar and sometimes revolting articles of food. I recall one patient who subsisted almost exclusively upon deviled crabs throughout the entire duration of pregnancy, and another who could retain nothing for the first few months except broiled lobster and Bass's ale.

Reference has already been made to the mental and emotional changes which sometimes characterize pregnancy, and occasionally we meet with women who diagnose their condition mainly from the occurrence of changes in their own temperament with which they have become familiar in previous pregnancies.

Decreased Sugar Tolerance.—As the result of the demonstration by Nürnberger and others that the renal threshold for sugar is definitely lowered during the first months of pregnancy, Welz and Van Nest have utilized the phenomenon as a diagnostic test for the existence of early pregnancy. For this purpose, the fasting patient is catheterized and a specimen of blood taken; 150 grams of glucose are then given by mouth, and 45 minutes later the urine is tested for sugar, and afterwards at half hourly intervals. As soon as a positive result is obtained, a second sample of blood is withdrawn and its sugar content is determined. The authors consider that decreased tolerance and the existence of pregnancy are demonstrated, whenever glycosuria develops, and the sugar content of the blood does not exceed 190 milligrams to 100 cubic centimeters. They state that the diagnoses thus made were correct in 95 per cent of their early pregnant patients, but became less accurate later. In my limited experience the test has not been reliable.

Changes in the Blood Serum.—Fieux and Mauriac believe that in the early months of pregnancy the serum contains an antibody, whose presence can be revealed by the deviation of complement reaction, when young chorionic villi are used as antigen. I have had no experience with the method. Neumann and Hermann, in 1911, described a very simple test, which they believed was based upon the increase in the amount of lipoids which occurs during the later months of pregnancy. The reaction consists of adding a drop of distilled water to a filtered alcoholic extract prepared from 1 cubic centimeter of blood. The fluid becomes turbid if pregnancy exists, but remains clear in nonpregnant women. Further experience, however, has failed to establish its usefulness.

Linzenmeier claims that in early pregnancy diagnostic use can be made of the rapidity with which the corpuscles settle, as he found that they did so in two hours or less in pregnant women, instead of in six hours, as in the case with normal blood.

Abderhalden's Reaction.—In 1912, Abderhalden described what he believed to be a universally reliable method for recognizing the existence of pregnancy by means of certain changes occurring in the blood serum of the woman. The method was based upon a plausible theory, aroused the greatest interest, promptly gave rise to an immense literature, and was finally abandoned by its originator; but nevertheless it deserves mention.

The theory was based upon the fact that fœtal elements are constantly gaining access to the maternal blood stream (deportation), and Abderhalden postulated that such foreign proteins must be rendered harmless in some way. He assumed that it was accomplished by the development of a specific ferment in the maternal blood, which possessed the power of breaking down the fœtal protein into amino-acids. If this were correct, he further assumed that the process could be imitated *in vitro,* and thus be made available for clinical use. For this purpose, he placed in a dialyzing tube 1 cubic centimeter of the serum to be tested along with a definite quantity of a specially prepared placental peptone, and immersed the tube in a small flask containing distilled water and kept it in the thermostat for sixteen hours. If the patient were pregnant, the ferment in her serum would break down the placental protein, and the amino-acids would pass into the dialyzate, where their presence could be demonstrated upon heating after the addition of a solution of ninhydrin (triketohydrindenhydrate).

At first, Abderhalden held that the test was specific and claimed that failures were the result of defective technic. Gradually, it was demonstrated that positive results could be obtained in nonpregnant women and sometimes even in men, so that the method was eventually abandoned. Although defective, the reaction served a useful purpose in that it concentrated attention upon the deportation of fœtal elements, as well as upon the fact that the composition of the serum of pregnant women is more complicated than was formerly believed.

Alcohol-extract Reaction.—For a number of years several of the associates of Sellheim have attempted to improve upon the Abderhalden technic. Eventually, they concluded that whatever changes occurred in the serum were not the result of ferment action and could be demonstrated by physical chemical means without the necessity of resorting to dialysis. The gist of their work was published in monographic form by Lüttge and Merz, in 1927. They gave complicated directions for the preparation of an alcoholic extract of placental tissue, which, when mixed with maternal serum and heated, gave a characteristic reaction with ninhydrin if pregnancy existed.

Moreover, they stated that it is possible to determine the sex of the unborn child by a serum reaction, and held if it were a male that certain substances would pass into the maternal blood serum which possess the property of breaking down a substance prepared from testicular tissue. Consequently, if the result is positive, the child is a male, while a negative result indicates that it is a female.

The publications of Lüttge and Merz are unusually verbose and indefinite, so that it is difficult to follow their directions, which I have not attempted to do. Those who have done so, however, report inconclusive results, so that it is likely that the alcohol-extract reaction will go the way of many other proposed tests.

Hormone Test for Pregnancy.—A. C. Siddall, in 1928, introduced a test which is based upon the supposed presence of the ovarian or placental hormone in the serum of pregnant women, and its ability to cause hypertrophy of the internal genitalia of immature mice. For this purpose, 1 cubic centimeter of serum from the woman to be tested is injected into an immature mouse. Several days later the animal is killed, and the ratio is determined between its total weight and that of the uterus, tubes and ovaries. If it exceeds 400 to 1, the result is considered negative, but if the ratio falls below that figure, the patient is regarded as pregnant. Siddall claims to have obtained correct results in more than 95 per cent of his cases. I have had no experience with the method, but, in view of what will be said in the next few paragraphs, it is probably based upon a sound foundation.

This method was modified, and placed upon a more secure foundation by Aschheim in 1929, who utilized the fact that the sex hormone of the anterior lobe of the pituitary body is excreted through the urine of the pregnant woman. In order to make the diagnosis, he injects into immature mice 1.2 to 2.4 cubic centimeters of the urine to be tested on six occasions during the course of forty-eight hours, and kills the animal 100 hours later. If the woman is pregnant, the ordinarily immature ovaries show unusual signs of activity, as manifested by pronounced luteinization and by hemorrhage into the follicles—the so-called blood points. Usually the changes are readily recognized by the naked eye, but occasionally the study of microscopic sections is necessary. In 1930 he reported that he had tested the method in 1007 cases, and obtained only 4 positive results in 548 nonpregnant, as contrasted with 8 negative results in 459 pregnant women—an error of only 1.2 per cent.

Zondek and Aschheim suppose that the reaction is due to folliculin or oestrin, which is formed by the ovaries activated by the pituitary hormone. In my experience the activity of the latter is still more strikingly demonstrated by the great hypertrophy of the uterus which occurs when castrated adult mice are used. That the hormone is at least partly secreted by, or stored in, the chorionic epithelium is shown by the intense and prolonged reaction which follows the use of urine from women suffering from hydatidiform mole. Such reactions, unfortunately, cannot be carried out by the ordinary practitioner, as they require special technical training. They are, however, of great scientific interest, as they serve to demonstrate what radical changes pregnancy brings about in the entire economy of the woman.

Dienst, in 1928, also described a urinary test for the detection of pregnancy, which he believes depends upon a characteristic increase in the antithrombin content of both the serum and urine during that condition, and in this event a smaller quantity of ninhydrin is required to give a characteristic blue reaction with urine than at other times. He believes that the test is positive if 10 centimeters of urine, to which 0.1 cubic centimeter of 1 per cent ninhydrin solution is added, takes on a definitely lilac color after being boiled for exactly twenty-five seconds. As yet, no one has confirmed Dienst's statements, nor have I had the curiosity to do so.

Differential Diagnosis of Pregnancy.—The pregnant uterus is often mistaken for other tumors occupying the pelvic or abdominal cavities, and *vice versa,* though, as a rule, the former mistake is more frequently made. The early periods of pregnancy may be simulated by enlargement of the uterus due to interstitial or submucous myomata, sarcoma, hematometra, and conditions resulting from inflammatory disturbances. As a rule, the uterus in these circumstances is harder and firmer than in pregnancy, and does not present its characteristic elastic or boggy consistency. Moreover, except in hematometra, such conditions are not attended by cessation of the menses. If, however, there is any possibility of a mistake, a delay of a few weeks will usually clear up the diagnosis.

The pregnant uterus is occasionally mistaken for a small ovarian or tubal tumor, though this error should rarely occur if the patient be carefully examined bimanually and the pelvic contents isolated, if necessary under an anesthetic. As the tumor becomes larger and rises up into the abdomen, other points become available for differential diagnosis, notably the positive signs of pregnancy and the intermittent contractions of Braxton Hicks.

The diagnosis of pregnancy in a myomatous uterus often presents serious difficulties, and for a time may be impossible. But a short delay will show a more rapid increase in the size of the tumor than is consistent with the existence of an uncomplicated myoma, and variations in the consistency of its different parts should also serve to direct one's attention to the pregnant condition.

Occasionally, an ovarian cystoma may be complicated by pregnancy. In the early stages the diagnosis, as a rule, can be easily made, as careful bimanual examination should enable one to differentiate between the two tumors; but in the later months it may become extremely difficult and sometimes impossible, owing to the increased distention of the abdomen. Furthermore, if the positive signs cannot be elicited, the existence of pregnancy is usually overlooked and a simple cystoma diagnosticated; whereas, if the heart sounds are heard and the x-ray findings are positive, the cystoma may escape recognition and the excessive abdominal enlargement be attributed to a hydramnios.

In the early months hypertrophy of the supravaginal portion of the cervix may seriously increase the difficulties of diagnosis, as the enlarged cervix may be mistaken for the entire uterus, the soft and elastic body being either overlooked or regarded as a tumor of the uterine appendages. Careful bimanual examination under anesthesia usually does away with the possibility of this error.

Irregular development of the pregnant uterus, associated with a sacculation of its anterior or posterior wall, may seriously complicate the diagnosis, especially if the fœtus be dead; as even after the most careful examination the existence of pregnancy may remain unrecognized and the sacculation be mistaken for an ovarian cyst. This is especially apt to occur when the sacculation occupies the posterior wall, as in such cases the anterior wall may remain practically unchanged, and when, under anesthesia, one can feel the fundus with both tubes extending from it, it is a pardonable error to conclude that the fluctuant tumor lying posterior to it is an ovarian cyst.

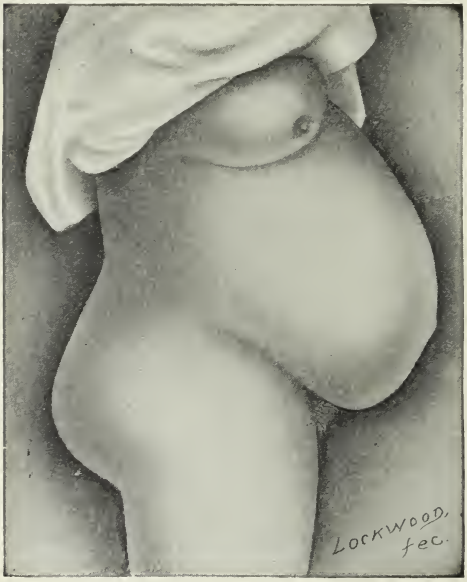

Fig. 204.—Abdominal Enlargement Due to Fat, the Patient Imagining Herself to be in the Last Month of Pregnancy.

Spurious Pregnancy.—Imaginary pregnancy, or *pseudocyesis,* is a condition with which almost every practitioner, sooner or later, will meet. It is usually observed in patients nearing the menopause, or in younger women who intensely desire offspring. Such patients may present all the subjective symptoms of pregnancy, associated with a considerable increase in the size of the abdomen, which is due either to an abnormal and rapid deposition of fat or to the existence of tympanites and occasionally of ascites. When it occurs in the earlier years of life the menses do not, as a rule, disappear, but they may present certain abnormalities which the patient may consider are due to her supposed condition.

In many instances the woman may imagine that she detects fœtal movements, which are sometimes so violent as to make her fearful that they may be visible to onlookers. I recall a patient who imagined herself in the last months of pregnancy, and who, while talking to me, exclaimed at the violence of the movements, but on examination I found that her uterus was normal in size, and that the enlarged abdomen was due to a rapidly increasing deposit of fat.

The supposed fœtal movements usually result from contractions of the intestines or the muscles of the abdominal wall, and occasionally are so marked as to deceive even physicians. Careful examination of the patient usually enables one to arrive at a correct diagnosis without great difficulty, as the small uterus can be demonstrated on bimanual examination, made, if necessary, under anesthesia. The greatest difficulty in these cases is to persuade the patient as to the correctness of the diagnosis. Bichebois has pointed out that insane women frequently suffer from the delusion that they are pregnant, and persist in such a belief for years.

Distinction between First and Subsequent Pregnancies.—Occasionally, it is a matter of practical importance to decide whether a patient is pregnant for the first time or has previously borne children. Ordinarily, childbearing leaves indelible traces behind it, which are readily appreciated; but very exceptionally such signs are lacking, as in a case reported by Budin (see Fig. 33). Again, in very rare instances, all the signs indicating a previous labor may follow the removal of a large tumor through the vagina.

In a pregnant woman who has never borne children the abdomen is usually tense and firm, and the uterus is felt through it only with difficulty. The characteristic abdominal striæ and the distinctive changes in the breasts are readily observed. The labia majora are usually in close apposition, the frenulum is intact, and the hymen torn in several places. The vagina is usually narrow and marked by well-developed rugæ. The cervix is softened, but does not usually admit the tip of the finger until the very end of pregnancy; and during the last four to six weeks of pregnancy the presenting part is found engaged in the superior strait, unless some disproportion exists.

In multiparous women, on the other hand, the abdominal walls are usually lax, flabby, and frequently pendulous, and the uterus is readily palpated through them. In addition to the pinkish striæ due to the present condition, the silvery cicatrices of past pregnancies may also be noted. The breasts are usually not as firm as in the first pregnancy, and frequently present striæ similar to those observed on the abdomen. The vulva is usually more or less gaping, the frenulum has disappeared and the hymen is replaced by the *carunculæ myrtiformes*. The external os, even in the early months of pregnancy, usually shows signs of laceration, and at a little later period readily admits the tip of the finger, which can be carried up to the internal os. Furthermore, in the majority of cases the presenting part does not engage in the superior strait until the onset of labor.

Diagnosis of the Life or Death of the Fœtus.—Generally speaking, the fœtus should be considered to be alive unless definite evidence to the contrary can be adduced. In the early months of pregnancy the diagnosis of fœtal death offers considerable difficulty, and can be made only after repeated examinations have demonstrated that the uterus has remained stationary in size for a number of weeks.

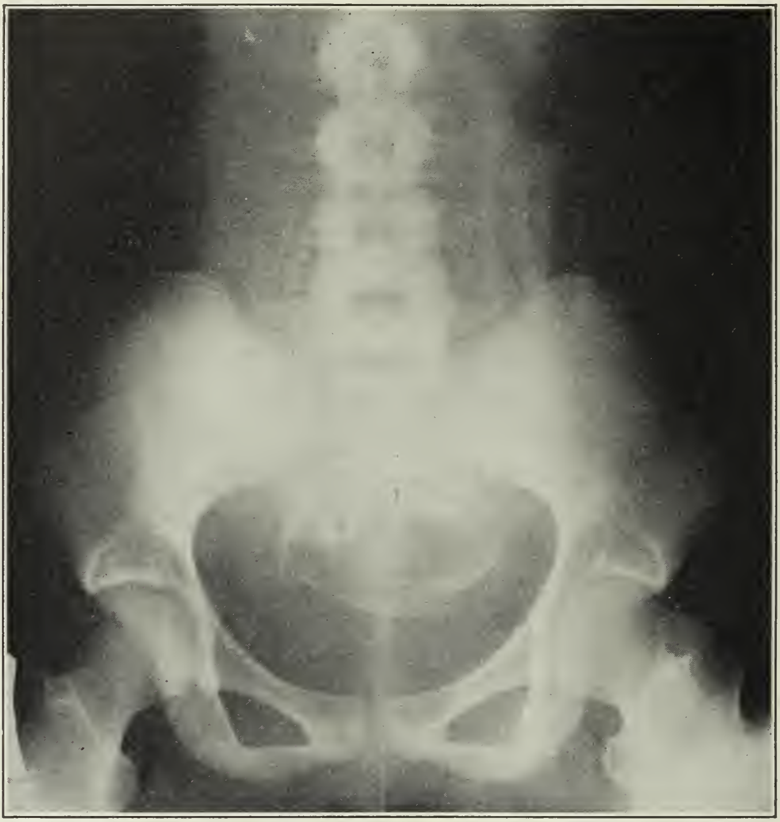

Fig. 205.—X-Ray Showing Collapse of Bones of Skull in a Case of Missed Labor.

In the later months of pregnancy, the disappearance of fœtal movements usually directs the attention of the patient to this possibility; moreover, she may suffer from ill-defined sensations, such as chilliness, languor, a sensation of weight in the abdomen, and perhaps a foul taste in the mouth. Careful investigation shows that the uterus does not correspond in size with the estimated duration of pregnancy, or even has become smaller than previously; while at the same time retrogressive changes have occurred in the breasts, which have become soft and flabby. The diagnosis cannot usually be made at a single examination, and is permissible only after repeated examinations, when in addition to the signs just mentioned one has failed to hear the fœtal heart or perceive the movements of the child.

Occasionally, a positive diagnosis can be made at once by palpating the macerated skull through the partially dilated cervix; in this event one feels that the bones of the head are loose and present a sensation as if they were contained in a flabby bag. Spalding showed that a positive diagnosis of fœtal death can sometimes be made by the employment of the röntgen ray. In such cases the plate will show overlapping of the bones of the skull at the several sutures, associated with distinct signs of shrinkage of the skull contents. Figure 205 shows the conditions at the expected date of confinement, in a patient whose uterus had shown no increase in size for three months.

Duration of Pregnancy.—As we have no means of ascertaining the exact date at which fertilization occurs, it is apparent that strictly accurate statements as to the duration of pregnancy cannot be made. Although conception may occur at any time, it is now generally believed that it is most usual somewhere about the middle of the intermenstrual period. Usually labor ensues about two hundred and eighty days (ten lunar months) after the first day of the last menstrual period, so that the actual duration of pregnancy is two hundred and seventy days or less. This rule, however, is subject to many exceptions, as apparently well-developed children may be born as early as the two hundred and fortieth and as late as the three hundred and twentieth day after the last menstrual period.

Every one practicing obstetrics occasionally meets with cases in which the patient believes that she has passed a month beyond term; or, in other words, that the pregnancy has lasted eleven lunar months. This belief, however, is usually erroneous, and in the majority of cases is due to some miscalculation. Exceptionally, however, pregnancy may last for an abnormally long period, and I recall a patient who on two occasions did not fall into labor until considerably over eleven months after the last period. In both instances the children weighed over 12 pounds, were 55 centimeters in length, and presented markedly increased thoracic measurements.

Winckel, after carefully studying his material, stated that about one-seventh of all children weighing 4000 grams or more (9 pounds) had been carried for three hundred and two days or longer after conception, and that in very exceptional instances pregnancy may last as long as three hundred and thirty-six days. According to the German law, three hundred and two days after the last period constitutes the limit for legitimacy. Recently, this has given rise to considerable discussion, and it appears that strict application of the law sometimes results in great injustice. Siegel states that this term is frequently exceeded and may be as long as three hundred and thirty-one days.

Even when we know the date of the coitus from which the pregnancy has resulted, we are in no better position to estimate the actual length of pregnancy, inasmuch as Löwenhardt has pointed out that two women may have fruitful coitus on the same day, and yet the date of their deliveries may vary markedly. Ahlfeld analyzed four hundred and twenty-five cases in which the date of coitus was supposed to be known, and found the average duration of pregnancy to be 269.91 days; but individual cases in the series varied from between two hundred and thirty-one to three hundred and twenty-nine days.

Similar differences are reported by veterinarians, who usually date the beginning of pregnancy from a single coitus. For example, the average duration of pregnancy in the mare is three hundred and sixty-six days, but individual variations between three hundred and seven and four hundred and twelve days have been noted. In the cow the normal duration is placed at two hundred and eighty days, with extremes of two hundred and forty and three hundred and eleven days. Again, as Mme. Laurié has shown, the duration of pregnancy also depends upon the extent to which the patient can spare herself during the last three months of pregnancy. This observer found that it was twenty days longer in 1550 women who lived comfortably in a hospital for several months prior to delivery than in the same number of women who entered at the onset of labor. Her figures, then, go to show that hard work in poorly nourished women predisposes to the premature ending of pregnancy.

In view of these facts we must conclude that the duration of pregnancy varies within certain limits, which probably depend upon individual peculiarities, and that it sometimes exceeds two hundred and eighty days from the last menstrual period. Generally speaking, however, prolongation of pregnancy should not be assumed unless the child weighs at least 4000 grams and the history indicates that eleven lunar months have elapsed since the last menstruation. As the postmature child may give rise to serious dystocia by its mere size, it is the part of wisdom to regard with suspicion every patient whose menstrual history indicates that she has passed beyond the tenth lunar month, and to make weekly examinations in which particular attention is directed toward recognizing the existence of disproportion between the head of the child and the pelvic inlet, and labor should be induced as soon as one is convinced that the normal proportions are exceeded.

Estimation of the Probable Date of Confinement.—Unfortunately for the comfort of the patient, as well as of the physician, we possess no reliable means of estimating the exact date, but are obliged to content ourselves with the method proposed by Naegele, which is based upon the belief that labor occurs two hundred and eighty days from the beginning of the last menstrual period. The calculation is readily made by adding seven days to the date at which the last menstrual period first appeared, and then counting back three months. For example, if the last period began on January 10, we add seven days, making January 17, and count back three months, thus fixing upon October 17 as the probable date of confinement.

In a small number of cases the patient will be confined on the precise day estimated, and in the great majority of cases within a few days of it; but occasionally a period of several weeks may elapse before labor occurs. Accordingingly, the physician should hesitate to predict a definite day for the confinement, and should always allow a margin of two to three weeks in his calculations. I have made the interesting observation that in many young women who miss the first menstrual period after marriage, a fully developed child is born two hundred and eighty days from the beginning of the last menstrual period. As this is less than nine calendar months after the date of marriage, it would indicate that pregnancy does not always last as long as ten lunar months.

Löwenhardt believed that the duration of pregnancy was ten menstrual periods, and considered the labor as likely to occur when the tenth period following conception fell due, and Schatz has adduced considerable evidence along similar lines. Accordingly, in patients menstruating at intervals of twenty-six or thirty days, for example, the duration of pregnancy would be two hundred and sixty or three hundred days, respectively. In the long run, however, this method of calculation does not give more accurate results than that of Naegele.

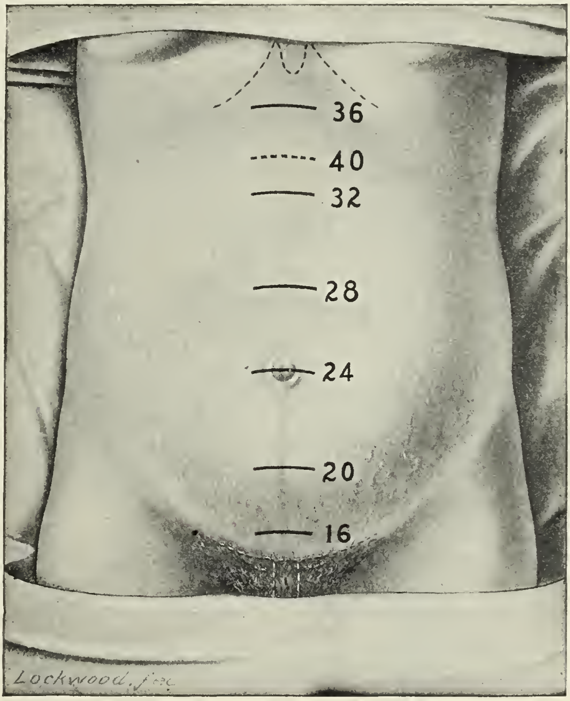

Fig. 206.—Relative Height of the Fundus at the Various Weeks of Pregnancy.

Occasionally the patient believes that she can date her pregnancy from a single coitus, and prefers to estimate the approaching date of confinement from that rather than from the beginning of the last period. This method is subject to quite as great an error as if calculated from the latter date, as we have no means of ascertaining when ovulation takes place, nor how long the spermatozoa may remain in the genital tract before conception occurs.

Frequent attempts have been made to estimate the date of confinement by adding twenty or twenty-one weeks to the date upon which the patient first perceived fœtal movements. This method is founded on the belief that quickening is first experienced at the eighteenth or twentieth week of pregnancy. Unfortunately, this assumption is erroneous, as the symptom is frequently first noticed at a much earlier period, and sometimes not until considerably later.

In not a few instances, especially in nursing women, conception may take place during a period of amenorrhea, and the patient is often surprised by the enlargement of her abdomen or by the perception of fœtal movements; while occasionally the first intimation that she is pregnant is given by the fact that her milk, which has previously agreed very well with the infant, suddenly becomes indigestible. Under such circumstances, the usual methods of calculation are of no value, and we have to depend upon other means, which, unfortunately, are extremely unsatisfactory.

In such cases our calculations are based upon the enlargement of the abdomen and the height to which the fundus of the uterus has risen. Generally speaking, with the patient on her back, we find that the fundus at the fourth month is several fingers'-breadths above the symphysis pubis; at the fifth month midway between it and the umbilicus; at the sixth month at the level of the umbilicus; at the seventh month three fingers'-breadths above the umbilicus; at the eighth month an equal distance above its position at the seventh month; at the ninth month just below the xiphoid; whereas in the last month, particularly in primiparous women, it sinks downward and assumes almost the position it occupied at the eighth month.

This method, however, gives only approximate results, as the position of the umbilicus is subject to marked variations, while the distention of the uterus is dependent not only upon the size of the child, but also upon the quantity of amniotic fluid. According to Spiegelberg, the situation of the umbilicus varies from 13 to 28 centimeters above the symphysis, so that there may be a difference of 6 inches in its position. On this account it has been thought preferable by some authors to estimate the distance of the fundus from the symphysis pubis with a tape measure, the average results obtained by Spiegelberg being as follows:

Week	*Centimeters*
22d to 28th	24.0 to 24.5
28th	26.7
30th	28.4
32d	29.5 to 30
34th	31.0
36th	32.0
38th	33.1
40th	33.7

These measurements, likewise, are subject to considerable variations, as they are dependent not only upon the size of the fœtus contained within the uterus, but also upon the degree of distention of the abdominal contents. Nevertheless, in cases in which we possess no other data, they occasionally afford information of very considerable value.

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CHAPTER VIII

THE MANAGEMENT OF NORMAL PREGNANCY

From a biological point of view, pregnancy and labor represent the highest function of the female reproductive system, and *a priori* should be considered as a normal process. But when we recall the manifold changes which occur in the maternal organism, it is apparent that the borderline between health and disease is less distinctly marked during gestation than at other times, and derangements, so slight as to be of but little consequence under ordinary circumstances, may readily be the precursors of pathological conditions which may seriously threaten the life of the mother or the child, or both.

It accordingly becomes necessary to keep pregnant patients under strict supervision, and to be constantly on the alert for the appearance of untoward symptoms. In private practice services of an obstetrician should be engaged early in pregnancy, as upon him devolves the duty of advising the patient as to her mode of life during the months preceding labor. Any one who has a moderately extensive obstetrical practice can save himself no little trouble by having cards printed, which briefly outline what the patient is expected to do, and in which are enumerated the various abnormal symptoms which may occur and to which the physician's attention should be immediately called. I reproduce below the card which I give my patients, and in the chapter on the conduct of labor the one prepared for the nurse.

Unless it be found upon inquiry that the patient has been leading an ill-ordered existence, very little change should be made in her mode of living, and she should be encouraged to go on much as usual, care being taken that she receives the proper amount of exercise, amusement, and diversion. It is the duty of the physician to gain the confidence of his patient and encourage her to come to him whenever anything occurs to worry her, instead of taking advice from her women friends. A woman in her first pregnancy generally stands in need of a certain amount of reassurance with regard to the dangers of parturition, and the knowledge that she is in the hands of a competent and careful physician will contribute largely to her peace of mind as well as to her physical well-being.

One of the few creditable achievements of American obstetrics consists in the development of so-called "Prenatal Care." The term has a wider application than the words imply, and may be defined as such supervision and care of the pregnant, parturient and puerperal woman as will enable her to pass through the dangers of pregnancy and labor with the least possible risk, to give birth to a living child, and to be discharged in such condition that she may be able to suckle it and thus afford it the greatest prospect of attaining maturity, as well as to fulfill her duties as mother and housewife with a minimal amount of invalidism. In hospital practice the first step in such a program consists in organizing the obstetrical dispensary and indoor service as a single unit. The patients should be taught to register early in pregnancy, and to return to the dispensary monthly until the seventh month and every two weeks thereafter, irrespective of whether they expect to be delivered in the hospital or in their own homes. At the first visit, in addition to a careful physical examination, a sample of blood should be obtained for the Wassermann test, and at each subsequent visit the urine should be examined, the blood pressure taken, the patient weighed, and any other abnormality be detected, with a view to checking it in its incipiency or to admitting the patient to the hospital for its relief or cure, if necessary.

On account of lack of intelligence and indolence many patients will fail to follow the directions given unless they are supervised by prenatal nurses, and I know of no way in which money can be better expended than in providing for this type of care. Those interested in the subject will find in the 1915 Transactions of the American Association for Study and Prevention of Infant Mortality the report of a committee, of which I was Chairman, upon suitable methods of recording prenatal work.

Exercise.—During normal pregnancy the woman should be encouraged to take as much outdoor exercise as possible, though in individual cases it is often difficult to specify the exact amount—a safe rule being to instruct her to desist while still feeling that she could do more without tiring herself. Exercise should consist of walking, driving or motoring over good roads, but the ordinary sports should be interdicted, though in the early months sea bathing is beneficial. When for various reasons outdoor exercise cannot be taken, massage in the hands of a skillful person is to be recommended. In the later months long journeys should not be undertaken unless absolutely necessary, and driving over rough roads should be avoided. When possible, the woman should lie down for an hour after the midday meal. Sleep is not essential, but the clothes should be loosened and the mind diverted from its usual channels.

Among the poorer classes the patients should be cautioned against excessive work, especially during the later months, as overexertion has been shown to play an important part in the production of premature labor.

Diet.—In normal pregnancy the diet should be abundant and nourishing, and ordinarily the patient should be allowed to continue her usual customs, but should be warned to abstain from very highly seasoned or indigestible articles of food. Accordingly, a special diet is not indicated unless some complication, such as toxemia of pregnancy, supervenes, and the necessary directions will be given under the appropriate headings. As indicated above, the patient should be weighed at each prenatal visit, and particularly during the last three months, as Zangemeister has shown that an excessive gain at that time usually indicates an "occult" edema which frequently affords the first indication of an impending toxemia. Fortunately, this can often be controlled by a restricted diet and rest in bed, and in such circumstances surprising losses of weight may follow within a few days. Likewise, in slight degrees of pelvic contraction, or in patients who have previously given birth to excessively heavy children, a restricted diet may be advisable during the latter months, as I have already stated that the larger size of the children in the well-to-do classes is in great part attributable to the life of ease and the abundance of food enjoyed by the mothers. Prochownick years ago contended that a diet poor in carbohydrates and fluids sometimes exerts considerable influence in lessening the weight of the child without otherwise affecting it, and these precautionary measures may obviate a difficult delivery. Such restrictions stand in marked contrast to those usually advocated by the laity, who erroneously believe that abstention from proteid food is the essential point. On the other hand, too much should not be expected from such a régime, as experience teaches that it is practically impossible to reduce the weight of the child much below the usual limits. For example, it is well known that women in the last stages of tuberculosis frequently give birth to well-developed children; while Hofmann states that during the so-called "hunger blockade" the undernourished German women bore children of normal size, but frequently they were unable to suckle them. Moreover, the work of Zuntz upon experimental animals demonstrates that during pregnancy a diet notoriously defective in one or more of its constituents has no effect upon the weight of the offspring, but that such undernourished animals are relatively sterile—a conclusion which is endorsed by Reynolds and Macomber.

The Bowels.—During pregnancy the enlarged uterus sometimes interferes with the normal intestinal peristalsis and gives rise to more or less marked constipation. Under such circumstances care should be taken that the bowels are moved daily, which is best accomplished by the administration of liquid petrolatum, phenolphthalein, cascara sagrada, or pills containing aloin, belladonna and strychnine. The use of active cathartics is inadvisable, unless their employment be specially indicated in certain morbid conditions.

Clothing.—The physician is frequently asked concerning the clothing which is best adapted to the pregnant state. Generally speaking, the clothing should be loose and so arranged as to exert as little pressure upon the waist as possible; and in the later months of pregnancy, if the patient is accustomed to the use of a corset, the ordinary type should be replaced by a loosely fitting corset-waist or by one of the specially designed "maternity" corsets. In multiparous women, when the abdomen is markedly relaxed from previous childbearing, the wearing of an abdominal support of elastic material, or an ordinary Scultetus bandage adds materially to their comfort. When varicose veins of the extremities are present the legs should be bandaged or encased in elastic stockings, and when large varices exist about the vulva the patient should be cautioned concerning the possibility of their rupture.

Sexual Intercourse.—In healthy persons sexual intercourse in moderation usually does no harm, as long as the abdominal enlargement is not too great to make it inconvenient for the patient. But where there is a tendency to abortion or premature labor it should be interdicted. It should also be forbidden in the last month of pregnancy, as in numerous instances severe puerperal infection has followed sexual intercourse just before the onset of labor.

The Breasts.—In the last months of pregnancy attention should be devoted to the condition of the breasts, and more particularly to the nipples, as by appropriate preliminary treatment nursing may be rendered easier, and the occurrence of fissures and the consequent danger of mammary infection in great part prevented. For this purpose the patient, during the last two months, should anoint her nipples night and morning with lanolin or cocoa butter, which tends to render them more elastic. When the nipples are small it is advisable to attempt to lengthen them by making a few tractions upon them night and morning; and where they are but slightly prominent good results sometimes follow the wearing of a wooden nipple shield for a few hours of each day, which is held in place by adhesive strips. I know of no means, however, by which retracted nipples can be made serviceable.

Urine.—Owing to the frequency of the toxemias of pregnancy and the serious consequences which frequently result from them, the urine should be carefully examined at regular intervals: once a month for the first seven months, and twice a month, or preferably every week, during the last three months of pregnancy. It is advisable that the physician should not only arrange definite periods at which specimens are to be sent, but that he should himself make a note of these dates, so that, in case the patient becomes careless and neglects to carry out his directions, he can remind her. Of course it may be very plausibly argued that the patient incurs the main risk from such neglect; but the prevention of a single death from eclampsia will amply repay the conscientious physician for much self-imposed labor. In hospital practice, it is more convenient to procure an absolutely fresh specimen each time the patient returns to the prenatal clinic.

The urine should be examined not only for the presence of albumin and sugar, but also microscopically. If more than a trace of albumin is detected, the amount should be determined daily by means of Esbach's albuminometer, and whenever it exceeds 0.5 gram to the liter, or symptoms indicative of toxemia are present, the patient should at once be put to bed at home or sent into the hospital for observation and treatment.

At each visit the blood pressure should be determined, and especial attention paid to variations in the diastolic pressure. Moreover, a systolic pressure of 140 millimeters or more should be regarded as a danger signal, especially if the diastolic pressure is likewise elevated, even though albumin and casts be absent from the urine.

In addition to giving the patient the advice above mentioned, the physician should also impress upon her the importance of informing him at once in case any of the following symptoms be noted. A scanty flow of urine, persistent headache, disturbances of vision, swelling of the feet and face, any loss of blood no matter how slight, and persistent constipation. In the majority of cases these symptoms are of secondary importance, but occasionally they serve to warn us of the imminence of some serious affection which may be cured or alleviated by appropriate treatment.

PRINTED DIRECTIONS FOR PRIVATE PATIENTS DURING PREGNANCY

(*a*) Take as much outdoor exercise as possible, but guard against overtiring yourself.

(*b*) See that the bowels are moved daily.

(*c*) On the first day of each month bring me a 4-oz. bottle of freshly passed morning urine; and for the three months preceding the expected date of confinement bring it on the first and fifteenth days of the month. Be sure to send your name with the specimen.

(*d*) From the seventh month onward anoint the nipples night and morning with lanolin or cocoa butter in order to render them more resistant to the strain of suckling.

(*e*) If you expect to be confined at home, buy a "Confinement Outfit" six weeks before the expected date. This includes everything needed by the nurse and myself, except baby's clothes. At the same time provide two pieces of rubber sheeting, ¾ × 1 yard and 1 × 2 yards respectively; a bed pan, two small round agate basins, a 2-quart fountain syringe and 15 yards of gauze and two pieces of cotton batting for making bed pads, or 4 ready-made sanitary bed pads.

(*f*) Go to the hospital as soon as labor pains commence, or, if you are to be confined at home, send for the nurse, and, unless some emergency arises, let her use her judgment in sending for me.

(*g*) Notify me at once if any of the following symptoms be observed at any time during pregnancy:

1. Scanty urine.
2. Persistent headache.
3. Disturbance of vision.
4. Swelling of feet or face.
5. Loss of blood.
6. Persistent constipation.
7. And also when you feel that anything is not as it should be.

(*h*) I shall want to see you five or six weeks before you expect to be sick in order to ascertain your condition and to give you any necessary advice.

Preliminary Examination.—In private practice it is not necessary to examine the pregnant woman vaginally in the early months of pregnancy unless symptoms indicative of some abnormality occur, or unless the patient does not expect to be under one's supervision throughout the entire duration of pregnancy; although it is my rule to examine every patient both locally and generally at her first visit. Furthermore, a second careful and thorough examination is indispensable about six weeks before the expected date of confinement, and to neglect in this respect can be attributed the deaths of untold numbers of women and children. At this time the general condition should be carefully noted, particular attention being also paid to the measurements of the pelvis, as well as to the size, presentation and position of the child.

Unless the physician fully appreciates the importance of this preliminary examination, and has learned to look upon the making of it as a bounden duty, he may sometimes be deterred by feeling that it is repugnant to the patient, and that she may object to it or even refuse it. My experience, however, has always been that a few words of kindly explanation soon smooth away all such difficulties; and when, as happens fortunately in the vast majority of cases, after the examination we can reassure the woman as to the prospects of a simple and safe delivery, she will feel amply repaid for any inconvenience to which she may have been subjected. On the other hand, if any abnormality is present, it is essential for the physician to know of its existence in advance, and, even though he may not always deem it advisable to communicate his conclusions to the patient herself, he will do well to inform the husband or some other responsible member of her family of the existing condition. If, however, despite the exercise of the greatest tact on the part of the physician, and his insistence that such an examination is a necessity for her own sake, the patient persists in her refusal, the former has no alternative but to decline to have any further connection with the case.

The first point in the preliminary obstetrical examination is careful *pelvic mensuration,* and Dohrn has well said that the physician who neglects pelvimetry is comparable to one who attempts to treat pulmonary diseases without the aid of auscultation and percussion. In the majority of instances the usual external measurements, including palpation of the pubic arch, are sufficient, provided the head is deeply engaged. If this is not the case, no matter how normal the external measurements may be, the pelvis must be explored internally and the length of the diagonal conjugate determined, if necessary under anesthesia. This is particularly necessary whenever the head does not engage during the last month of a first pregnancy, or in any patient in whom the pelvic outlet is contracted, or who limps or presents signs of deformity of the spine or legs. Failure to observe this precaution may occasionally lead to most unpleasant surprises at the time of labor. If an abnormality be detected at this examination the physician is both forewarned and forearmed, and in extreme cases he will be prepared to interfere at the proper time with every prospect of a successful issue.

After measuring the pelvis, the abdomen should be carefully examined, the duration of pregnancy estimated, and the existence of any abnormality, as hydramnion or twins, noted; after which the size, position and presentation of the child should be determined by *external palpation,* according to the rules which will be given later. An internal examination should always be made; for, while it is usually not necessary for the determination of the presentation and position of the child, it may reveal the presence of some abnormality of the generative tract—such as an ovarian cyst or a myoma—which might give rise to disastrous results if unrecognized. Furthermore, it is essential when palpation gives uncertain or unsatisfactory results, or when the head is not engaged in primiparous women or when the patient presents a history of previous difficult labors. The physician who knows how to utilize all the resources of external palpation and manipulation will find that by these means he can usually not only recognize normal and abnormal presentations in advance, but can also convert breech, transverse, or face presentations into those of the vertex.

When *vaginal exploration* is necessary at the preliminary examination, if undertaken prior to the end of the ninth lunar month, rigorous hand disinfection is not necessary, and the physician may content himself with the use of a nail-brush, soap, and hot water. In the last month of pregnancy, however, the use of a sterile rubber glove is imperative, for we have no means of knowing exactly when labor may supervene, and our neglect may occasionally give rise to puerperal infection.

As will be pointed out in more detail later, one of the most important duties of the physician is to bear in mind the possibility of undue prolongation of pregnancy which may result in the development of a child of excessive size. For this reason, whenever the patient does not fall in labor within a few days of the calculated date, she should be examined at weekly intervals, and, as soon as the impression is gained that the child has passed the usual limit in size, labor should be induced.

The various abnormalities occurring in the course of pregnancy will be considered in a separate chapter.

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CHAPTER IX

PRESENTATION AND POSITION OF THE FŒTUS—METHODS OF DIAGNOSIS

PRESENTATION AND POSITION OF FŒTUS

Irrespective of the relation which it may bear to the mother, the fœtus in the later months of pregnancy assumes a characteristic posture, which is described as its *attitude* or *habitus;* and, as a general rule, it may be said to form an ovoid mass, which roughly corresponds with the shape of the uterine cavity. It is usually taught that the fœtus is folded or bent upon itself in such a way that the back becomes markedly convex, the head is sharply flexed so that the chin is almost in contact with the breast, the thighs are flexed over the abdomen, the legs are bent at the knee joints, and the arches of the feet rest upon the anterior surfaces of the legs. The arms are usually crossed over the thorax or are parallel to the sides, while the umbilical cord lies in the space between them and the lower extremities. Warnekros, on the other hand, contends that the normal habitus is much less constrained, and that the contrary view is due to the fact that our conclusions have been based upon the study of frozen or hardened specimens, in which the uterus has become so retracted as to exert an abnormal pressure upon its contents. In his valuable x-ray atlas, he shows that before the onset of labor the head normally occupies a position midway between flexion and extension, the back is but slightly flexed, and the extremities are relatively freely movable—in other words, the fœtus is in an unconstrained position, analogous to that which it maintains outside of the uterus when at rest.

The attitude is frequently modified by changes in the consistency of the abdominal and uterine walls, by the abundance or lack of liquor amnii, as well as by movements of the extremities. Occasionally the head may become deflected, when a totally different posture is assumed. The characteristic attitude results partly from the mode of growth of the fœtus, and partly from a process of accommodation between it and the outlines of the uterine cavity.

Presentation.—By this term is understood the relation which the long axis of the fœtus bears to that of the mother, and we accordingly distinguish between longitudinal and transverse presentations. Occasionally during pregnancy the fœtal may cross the maternal axis at an angle, and thus give rise to oblique presentations; but, as these always become longitudinal or transverse during the course of labor, they need not be considered. *Longitudinal presentations* are noted in over 99 per cent of all labors at full term.

Considerable confusion has resulted from confounding the terms *presentation* and *presenting part*. By the latter we understand the portion of the fœtus which engages at the superior strait, and is felt through the cervix on vaginal examination. Accordingly, in longitudinal presentations the presenting part may be either the head or the breech, and we speak of *cephalic* or *breech presentations* respectively. When the fœtus lies with its long axis transversely, the shoulder is the presenting part, and we speak of *shoulder presentations*.

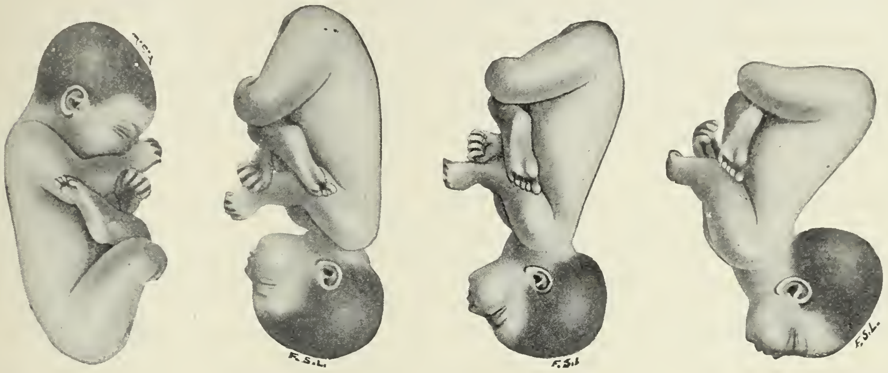
Fig. 207. Fig. 208. Fig. 209. Fig. 210.

Figs. 207-210.—Showing Difference in Attitude of Fœtus in Vertex, Sinciput, Brow, and Face Presentations.

Longitudinal presentations are broadly classified as normal, and transverse as abnormal, inasmuch as with the former the child is usually born by the unaided efforts of Nature; whereas if the latter persist spontaneous birth is impossible, and delivery must be effected with the aid of the obstetrician. These abnormal presentations will be considered in a separate chapter.

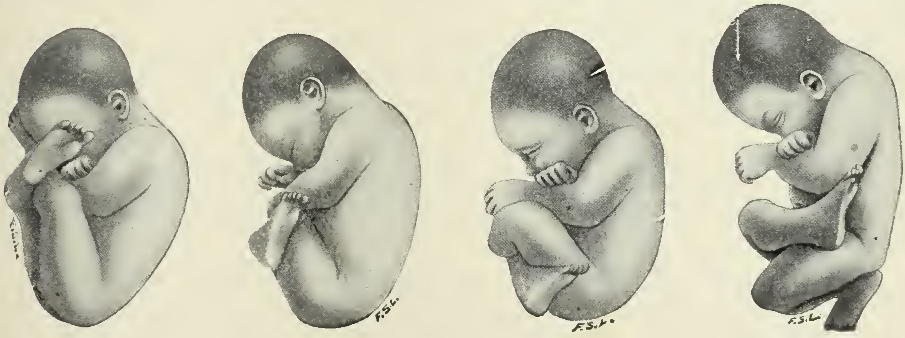
Fig. 211. Fig. 212. Fig. 213. Fig. 214.

Figs. 211-214.—Showing Difference in Attitude of Fœtus in Frank Breech, Full Breech, Foot, and Knee Presentations.

Cephalic presentations are divided into several groups, according to the relation which the head bears to the body of the child. Usually the head is sharply flexed, so that the chin is in contact with the thorax. In these circumstances the vertex is the presenting part—*vertex presentation.* More rarely the neck may be sharply extended, so that the occiput and back come in contact and the face engages in the superior strait—*face presentation.* Again, the head may assume a position intermediate between these extremes, being partially flexed in some cases, when the large fontanel presents—*sincipital presentation;* or partially extended in other cases, so that the brow becomes the presenting part—*brow presentation.* The last two are not usually classified as distinct varieties, as they are usually transient, and become converted into vertex or face presentations as labor progresses.

When the child presents by its pelvic extremity, the thighs may be flexed and the legs extended over the anterior surface of the body—*frank breech presentation;* again, the thighs may be flexed on the abdomen and the legs upon the thighs—*breech presentation;* or the feet may be the lowest part—*foot* or *footling presentation.* Occasionally one leg may retain the position which is typical of one of the above-mentioned presentations, while the other foot or knee may present—*incomplete foot* or *knee presentation.* As the mechanism of labor, however, is essentially the same in all modifications of pelvic presentations, the several varieties need not be considered separately.

Position.—By this term we designate the relation of some arbitrarily chosen portion of the child to the right or left side of the mother. Accordingly, with each presentation we have one or other of two positions—right or left. With us and in France, the occiput, chin, and sacrum are the determining points in vertex, face, and breech presentations respectively; while in Germany the child's back is the orienting portion.

Variety.—Furthermore for the purpose of still more accurate orientation, we take into consideration the relationship of some given portion of the presenting part to the anterior, transverse, or posterior portion of the mother's pelvis. Thus, as there are two positions, there will be in all six varieties for each presentation. But as the transverse varieties usually represent only a phase in the mechanism of labor, and are not persistent, they need not be taken into account.

Nomenclature.—Unfortunately, a universal nomenclature for designating the various presentations and positions has not as yet been agreed upon, and the methods employed vary in different countries and even in different parts of the same country, though of late there has arisen a greater tendency toward uniformity.

In the earlier works upon obstetrics, as in Roesslin's Rosengarten (1513), it was believed that the child might assume any imaginable position *in utero* and the number of presentations and positions was limited only by the ingenuity of the writer. More accurate observation gradually did away with the fanciful forms, but even as late as 1775 Baudelocque distinguished 94 different presentations. Madame La Chapelle (1821) materially simplified the subject, and the classification which she suggested differs but little from that employed in France to-day, which has been best described by Farabeuf and Varnier.

According to the French method, vertex, face, and breech presentations are designated as occipito-iliac (O.I.), mento-iliac (M.I.), and sacro-iliac (S.I.). At the International Medical Congress which met in Washington in 1887 an attempt was made to secure greater uniformity in nomenclature, when it was suggested that the denomination "iliac" be omitted and the various presentations designated as occipital, mental, and sacral respectively. The suggestion was quite generally accepted in America and Great Britain, and Bar, in 1903, advocated its universal adoption.

As the presenting part in any presentation may be either in the left or right position, we have left and right occiptal, left and right mental, and left and right sacral presentations, which in an abbreviated form may be written L. O. and R. O., L. M. and R. M., L. S. and R. S. Again, as the presenting part in each of the two positions may be directed anteriorly, transversely, or posteriorly, we may have six varieties of each presentation. Thus, we have the classification given on the following page.

In Germany considerable confusion exists, as the various authorities still employ different classifications. Thus Schroeder, Olshausen and Veit did not distinguish variety at all, and they designated the position according to the situation of the back of the child, speaking of first and second positions according as the back is directed to the left or right side of the mother respectively. Others employ a different nomenclature, and designate our L. O. A., R. O. A., R. O. P., and L. O. P. as first, second, third, and fourth positions, respectively. The exhaustive articles of Müller and Schatz deal fully with this subject.

Our nomenclature presents many advantages over the German, as it is based upon the relation of the presenting part to the maternal pelvis, and enables one to describe with accuracy the situation of the former at any period of labor.

Frequency of the Various Presentations and Positions.—According to the statistics collected by Schroeder, based upon several hundred thousand cases, the vertex presents in 95 per cent, the face in 0.6 per cent, and the breech in 3.11 per cent, transverse presentations occurring in only 0.56 per cent of all cases. Markoe, in fifty-one thousand deliveries occurring in the New York Lying-in Hospital, noted 94.2, 0.48, 3.9, and 0.9 per cent, respectively, while in the first seventy-five hundred admissions to the obstetrical service of the Johns Hopkins Hospital the incidence of the several presentations was 94.6, 0.34, 3.9, and 0.96 per cent, respectively. These figures apply to the conditions observed at or near full term, but prior to the seventh month breech and transverse presentations occur more frequently.

It is usually stated that about 70 per cent of all vertex presentations occur in the left, and only 30 per cent in the right position, and we have found 64 and 36 per cent, respectively. Schatz has shown that the former becomes more and the latter less frequent the nearer pregnancy approaches term. Naegele first

	Position	Presentation	Variety	Abbreviation
Vertex presentations	Left	Occipital	Anterior	L.O.A.
	"	"	Transverse	L.O. T.
	"	"	Posterior	L.O.P.
	Right	"	Anterior	R.O.A.
	"	"	Transverse	R.O.T.
	"	"	Posterior	R.O.P.

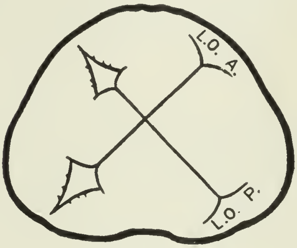

Fig. 215.

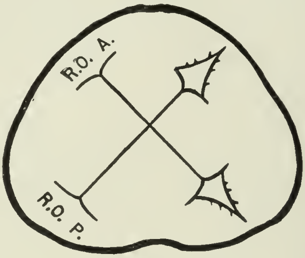

Fig. 216.

Figs. 215, 216.—Showing Varieties of Vertex Presentations.

Face presentations	Left	Mental	Anterior	L.M.A.
	"	"	Transverse	L.M.T.
	"	"	Posterior	L.M.P.
	Right	"	Anterior	R.M.A.
	"	"	Transverse	R.M.T.
	"	"	Posterior	R.M.P.

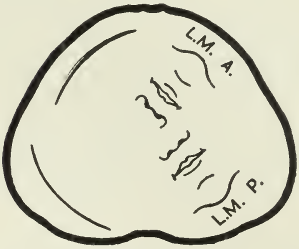

Fig. 217.

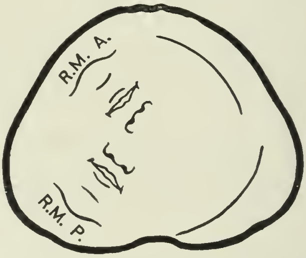

Fig. 218.

Figs. 217, 218.—Showing Varieties of Face Presentations.

Breech presentations	Left	Sacral	Anterior	L.S.A.
	"	"	Transverse	L.S.T.
	"	"	Posterior	L.S.P.
	Right	"	Anterior	R.S.A.
	"	"	Transverse	R.S.P.
	"	"	Posterior	R.S.T.

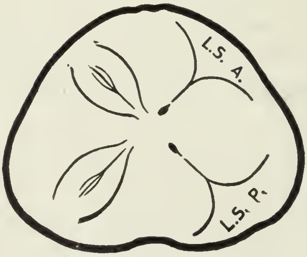

Fig. 219.

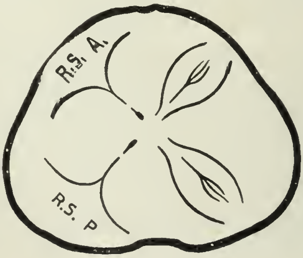

Fig. 220.

Figs. 219, 220.—Showing Varieties of Breech Presentations.

pointed out that the occiput was usually directed anteriorly in left, and posteriorly in right positions; so that it is usually found at one or other extremity of the right oblique diameter of the pelvis, owing to the fact that the left oblique diameter is materially encroached upon at its posterior extremity by the rectum.

Reasons for the Predominance of Head Presentations.—Hippocrates recognized the overwhelming frequency of head presentations at the end of pregnancy, but believed that the child presented by the breech up to the seventh month, when it suddenly turned and presented by the head, the process being often expressed by the French term *culbute*.

As a result of the more frequent examination of pregnant women, the error of the Hippocratic teachings was gradually demonstrated, so that from the time of Smellie and Baudelocque it was generally believed that head presentations predominated throughout all periods of pregnancy, but became more frequent in the later months. For many years it was taught that the presentation remained constant throughout pregnancy, and it was not until 1861 that Hecker and Schultze demonstrated that it was not unusual for changes of position to occur even in the later months. Now it is universally admitted that the presentation does not become definitely established until the presenting part enters the pelvic canal, although it becomes more and more stable the nearer full term is approached.

The theories put forward to account for the prevalence of head presentations are divided into two groups, the one being based upon gravitation, the other supposing a process of accommodation between the fœtus and the uterine cavity.

The *gravitation theory* was especially advocated by Matthews Duncan and G. Veit, both of whom showed that a fœtus recently dead, when placed in a vessel containing a solution of salt having about the same specific gravity as itself (1.058–1.055), floated with its head and right side downward. This result they attributed to the greater specific gravity of the head, together with the presence of the liver on the right side. Veit also showed that head presentations increase in frequency with the advance of pregnancy, but that breech presentations were noted much more frequently when the child was dead. This he attributed to the fact that the specific gravity of the head became diminished after death.

Furthermore, it was pointed out that since the axis of the uterus, with the woman in the upright position, forms an angle of about 35 degrees with the horizon, the head would necessarily sink downward, and the convex back of the fœtus would adapt itself to the concave anterior wall of the uterus; then, since the organ is usually so rotated about its long axis that its left margin is directed somewhat forward, the frequency of the left anterior presentations could be readily explained. Schatz, in 1904, showed that this tendency was increased under the influence of gravity. This he demonstrated by examining a series of women in the morning before arising, and again in the evening after they had been about all day, when he found that the anterior varieties of vertex presentations occurred more frequently in the evening. Warnekros has still further emphasized, by means of x-ray photographs, the part played by gravity by showing that a vertex can be converted into a breech presentation by placing the woman in the Trendelenburg posture, thereby reversing the direction in which gravitation acts.

In 1900, doubt was cast upon the conclusions of Duncan and Veit by Schatz, who maintained that, although their results were correct when experimenting with a medium of the same specific gravity as the fœtus, it does not necessarily follow that they hold good for the amniotic fluid, which, it must be remembered, possess a specific gravity of between 1.008 and 1.009, or considerably less than that of the fœtus. Schatz suspended a recently dead fœtus by the head and breech from the pans of a balance in a solution of salt of the same specific gravity as the amniotic fluid, and found that the breech had a greater tendency to sink down than the head; but, as the specific gravity of the fluid was gradually increased, the breech slowly rose until the long axis of the child became horizontal, and, as a density of 1.050 was approached, the head sank down as in Duncan's experiment. He therefore concluded that gravity alone does not account for the production of head presentations; for, if it were the most important factor concerned, breech presentations would predominate at the end of pregnancy. As this is not the case, some other influence must be invoked to explain the prevalence of the former. Seitz repeated this work, and upon determining the specific gravity of the head and body of the fœtus, separately, found that the former was relatively lighter than the latter in the first eight months, but heavier in the last two months of pregnancy. Consequently, he concluded that gravity could account for the predominance of head presentation only in the latter period. Furthermore, as the specific gravity was identical whether the fœtus were macerated or normal, and yet breech presentations were noted much more frequently in the former condition, he held that some other factor must be concerned.

This is supplied by the *theory of accommodation,* advanced by Dubois, Simpson, and Scanzoni, according to which cephalic presentations are brought about by a process of accommodation between the fœtal ovoid and the interior of the uterine cavity, the shape of the latter being such that the fœtus is most comfortable and fits it most accurately when presenting by the head. They held, therefore, that as soon as the fœtus came to occupy any other position its cutaneous surface became irritated, whence resulted reflex movements of the extremities, giving rise in turn to uterine contractions, which tended to restore the head presentation. Pinard and Sellheim are enthusiastic advocates of this theory; and the latter has indicated that but little force is needed to bring about such movements, as for practical purposes, the weight of the fœtus is almost negligible, being represented merely by the difference between its specific gravity and that of the amniotic fluid; namely 130 to 140 grams at full term.

The frequency of abnormal presentations in the early months of pregnancy, and in all conditions in which the uterus is abnormally distended by an excess of amniotic fluid, tends to substantiate the accommodation theory; for in such cases the body of the child does not come in contact with the uterine walls, and accordingly the conditions necessary for the production of the reflex movements, which give rise to accommodation, are entirely lacking, and gravity alone comes into play.

The subject was again taken up in 1915 by Barnum in this country and by Griffith in Great Britain, with the result that, while they were able to confirm the observations of Schatz and Seitz, they held that the latter had failed to take into consideration all the factors concerned. Both of the former investigators found in the last two months of pregnancy that the specific gravity of the head is greater than that of the body, but that, in the usual intrauterine habitus, the center of gravity of the entire fœtus lies slightly nearer the breech than the head, while the center of buoyancy, or the metacenter, is situated still nearer the breech. Consequently, as the latter must lie above the former in order for the fœtus to float in an approximately vertical direction, the head must descend. Furthermore, as Griffith estimates that the effective weight of the fœtus is only 4 to 5 ounces, it may readily be admitted that while gravity is the main factor involved, the process of accommodation may play an important part in causing changes in the position of a body presenting so slight an effective weight.

Notwithstanding the very considerable amount of research which has been done upon the subject, I do not believe that the final word has been spoken, and I would refer those interested to the articles of Barnum and Griffith, and to the monograph of Cohnstein published in 1868, for information concerning the various older theories.

DIAGNOSIS OF PRESENTATION AND POSITION OF FŒTUS

The diagnostic methods at our disposal are fourfold: abdominal palpation, vaginal and rectal touch, combined examination, and auscultation, and in certain doubtful cases the x-ray.

Obstetrical Palpation.—Under ordinary circumstances external or abdominal palpation is the most reliable and valuable, and I should unhestitatingly choose it were I restricted to the employment of a single method of examination. In trained hands it enables one to make a satisfactory diagnosis without danger of infection and with the least possible discomfort to the patient, and it is not going too far to say that its popularization forms one of the greatest advances in modern obstetrics. Accordingly it behooves the student to become thoroughly familiar with the proper technic, and to avail himself of every opportunity to become proficient in the various manipulations.

Although crude forms of abdominal palpation had no doubt been practiced from the earliest antiquity, just as they are still employed by many of the aboriginal peoples, its advantages were first pointed out by Roederer, Wigand,

and Hohl, as late as the latter part of the eighteenth and the early part of the nineteenth century. Its practical importance, however, was not generally recognized until 1878, when Pinard published his work upon the subject, after which the method became popularized in France, but was not employed systematically elsewhere until Credé and Leopold had repeatedly urged its value.

In order to obtain satisfactory results, the examination should be made systematically by following the four maneuvers suggested by Leopold. The patient should be on a firm bed or examining table, with the abdomen bared, or at most covered with a thin chemise. During the first three maneuvers the examiner stands at the side of the bed which is most convenient to him, and faces the patient, but reverses his position and faces her feet for the last maneuver (see Plates XI to XIV).

First Maneuver.—After outlining the contour of the uterus, and determining how nearly its fundus approaches the xiphoid cartilage, the fundus is gently palpated with the tips of the fingers of two hands, and the fœtal pole occupying it differentiated, the breech giving the sensation of a large, irregularly shaped, nodular body, and the head that of a hard, round object, which is freely movable and ballottable.

Second Maneuver.—Having determined which pole of the fœtus lies at the fundus, the examiner places the palmar surface of his hands on either side of the abdomen and makes gentle but deep pressure. On one side he feels a hard resistant plane—the back—and on the other numerous nodulations—the small parts. In women with thin abdominal walls the legs and arms can readily be differentiated, but in fat persons only irregular nodulations can be felt. In the latter case, or when a considerable quantity of amniotic fluid is present, the appreciation of the back can be facilitated by making deep pressure with one hand while palpating with the other. After determining upon which side the back is situated, we next note whether it is directed anteriorly, transversely, or posteriorly, and thereby gain an exact idea of the orientation of the body.

Third Maneuver.—The examiner grasps the lower portion of the abdomen, just above the symphysis pubis, between the thumb and fingers of one hand, and decides what is between them. If the presenting part be not engaged, a movable body will be felt, which is usually the head. The differentiation between it and the breech is made as at the fundus, the former being appreciated as a hard, round, ballottable body. If the presenting part be not engaged, this practically completes the examination, as we now know the situation of the head, breech, back, and extremities, and all that remains is to determine the attitude of the head. If careful palpation shows that the greatest cephalic prominence is on the same side as the small parts, we know that the head is flexed and that the vertex is the presenting part; but when the reverse is the case we know that the head is extended and that we have a face presentation. On the other hand, if the presenting part is deeply engaged, this maneuver simply shows that the lower pole of the fœtus is fixed in the pelvis, and the details concerning it are ascertained as follows:

Fourth Maneuver.—The examiner faces the patient's feet, and with the tips of the first three fingers of each hand makes deep pressure in the direction of the axis of the superior strait. If the head presents, he finds that one hand is arrested sooner than the other by a rounded body—the cephalic prominence; while the other hand descends deeper into the pelvis. In vertex presentations the prominence is on the same side as the small parts, and in face presentations on the same side as the back. Again, the degree of ease with which the prominence is felt indicates the extent to which descent has occurred. In many instances, when the head has descended into the pelvis, the anterior shoulder of the child can be readily differentiated by the third maneuver. In breech presentations the information obtained from this maneuver is not so definite.

Abdominal palpation is available throughout the later months of pregnancy, and in the intervals between the pains at the time of labor. By its use we can not only determine the presentation and position of the child, but also obtain important information as to the extent to which the presenting part has descended into the pelvis. For example, we know so long as the cephalic prominence is readily palpable that the vertex has not descended to the level of the ischial spines; whereas, when it can no longer be palpated from above the head has descended so deeply that its most dependent part can be palpated through the pelvic floor. Moreover, when there is disproportion between the size of the head and the pelvis, its seriousness can be gauged by determining the extent to which the anterior portion of the head overrides the symphysis pubis. Likewise, with practice, it is possible to estimate roughly the size of the child, while in twin pregnancy the second fœtus can be mapped out.

During uterine contractions, on carefully palpating in the region of the internal abdominal ring, one can often distinguish a rounded cord on either side —the *round ligaments*—from which important information may be obtained. In the first place, the intensity of their contraction gives some idea of the manner in which the uterus is acting; and secondly, by noting their course, it is possible to diagnose the situation of the placenta in about 80 per cent of all cases. Leopold and Palm showed that when the round ligaments converge toward the fundus of the uterus, the placenta is usually situated upon the posterior wall, whereas it is upon the anterior wall when they are parallel or diverging.

During labor, palpation also gives us valuable information concerning the *lower uterine segment;* when there exists some obstruction to the passage of the child, the *contraction ring* may be felt as a transverse or oblique ridge extending across the lower portion of the uterus. Moreover, even in normal cases, we can differentiate by palpation between the contracting body of the uterus and the passive lower uterine segment; for during a pain the former presents a firm, hard sensation, while the latter appears elastic and almost fluctuant.

Vaginal Examination.—During pregnancy the results arrived at by vaginal examination, concerning the presentation and position of the child, are necessarily somewhat inconclusive, for, as the cervix is still closed, one is obliged to palpate the presenting part through the lower uterine segment. During labor, on the other hand, after more or less complete dilatation of the cervix, important information may be obtained. In vertex presentations the position and variety are determined by the differentiation of the various sutures and fontanels; in face presentations, by the differentiation of the various portions of the face; and in breech presentations, by the palpation of the sacrum and ischial tuberosities.

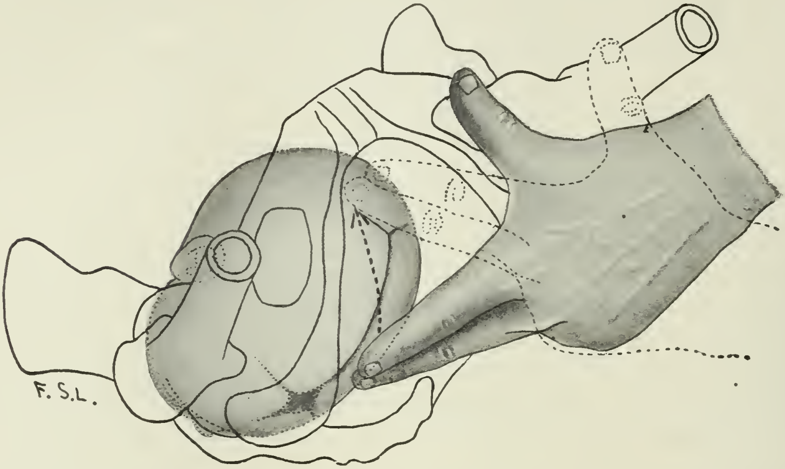

Fig. 221.—Diagram Showing Method of Locating Sagittal Suture on Vaginal Examination.

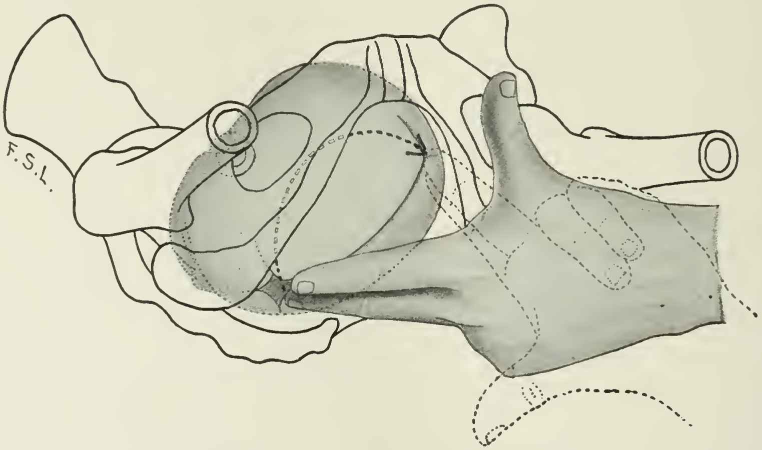

Fig. 222.—Diagram Showing Method of Differentiation between the Fontanels.

Under the most favorable circumstances the information to be derived from vaginal touch alone is not more accurate than that obtained by abdominal palpation, and in vertex presentations the fontanels are frequently mistaken for one another; and occasionally face and breech presentations escape differentiation. Moreover, later in labor, after the formation of the *caput succedaneum,* detection of the various diagnostic points often becomes impossible.

A much more serious objection, however, is the danger of puerperal infection, no matter how careful one's technic may be; for it is now generally admitted that absolute hand disinfection cannot be effected, and, even granting that the use of sterile rubber gloves overcomes this difficulty, the gloved fingers may still carry up into the vagina pathogenic micro-organisms from the margins of the vulva, and thus give rise to infection.

Accordingly, it is advisable to limit vaginal examination as much as possible, and in normal cases to do away with it altogether. For, if the preliminary examination has shown that the patient has a normal pelvis, and presents no other abnormality, and we find by the fourth maneuver that the head is deeply engaged, all that we gain by vaginal examination is information as to the degree of dilatation of the cervix, and the condition of the membranes, and this can usually be ascertained equally well by rectal examination. Accordingly, vaginal examination becomes absolutely necessary only in the few cases in which palpation and rectal examination do not give satisfactory results, or in patients presenting some abnormality, or in whom the course of labor is unduly delayed. Personally, I conduct the great majority of my private cases in this manner, and ordinarily do not make a vaginal examination until about to discharge the patient.

In attempting to determine the presentation and position by vaginal examination, it is advisable to pursue a definite routine, which is readily accomplished by three maneuvers.

First Maneuver.—After appropriate preparation of the patient, two fingers of either the right or left gloved hand, as best suits the examiner, are introduced into the vagina and carried up to the presenting part. A few moments suffice to determine whether it is a vertex, face, or breech.

Second Maneuver.—If the vertex be presenting, the fingers are carried up behind the symphysis pubis, and are then swept backward over the head toward the sacrum. During this movement they necessarily cross the sagittal suture. When it is felt, its course is outlined, and we know that the small fontanel must lie at one and the large fontanel at the other end of it.

Third Maneuver—We then attempt to determine the position of the two fontanels. For this purpose the fingers are passed to the anterior extremity of the sagittal suture, and the fontanel there encountered is carefully examined and identified; then, by a circular motion, the fingers are passed around the side of the head until the other fontanel is felt and differentiated. By this means the various sutures and fontanels are readily located, and the possibility of error is considerably lessened. In face and breech presentations it is still further minimized, as the various parts are more readily distinguished.

Combined Examination.—By combined examination we understand the introduction of two fingers of one hand into the vagina, and the application of the other hand over the lower portion of the abdomen. This method is rarely employed except when the presenting part is not engaged, and the external hand is used to fix it so as to permit the internal fingers to explore it satisfactorily, as well as to determine the existence of disproportion between the size of the head and the superior strait and its degree.

Auscultation.—By itself, auscultation does not give very important information as to the presentation and position of the child, but it sometimes reënforces the results obtained by palpation. Ordinarily, the heart sounds are transmitted through the convex portion of the fœtus, which lies in intimate contact with the uterine wall. Accordingly they are best heard through the back in vertex and breech, and through the thorax in face presentations. The region of the abdomen in which the fœtal heart is heard most plainly varies according to the presentation and the extent to which the presenting part has descended. In head presentations the point of maximum intensity is usually midway between the umbilicus and the anterior superior spine of the ilium, while in breech presentations it is usually about on a level with the umbilicus.

Auscultation frequently gives us not a little supplementary aid in determining the position of the child. Thus, in occipito-anterior presentations the heart is usually best heard a short distance from the middle line; in the transverse varieties it is heard more laterally, and in the posterior varieties well back in the patient's flank. Occasionally, however, in obliquely posterior positions, the information gained from the location of the fœtal heart is misleading, and may give rise to serious diagnostic errors; for if the flexion of the head be imperfect, the thorax may become convex, in which event the heart sounds may be transmitted through it and lead one to suppose that one has to deal with an obliquely anterior position.

X-Ray.—With the increasing perfection of x-ray apparatus, we have gained another diagnostic aid which is of particular value in doubtful cases. In fat women, or those with abdominal walls so rigid as to make palpation difficult, a well taken plate may clear up many diagnostic difficulties, and enable us to recognize the existence of a breech or transverse presentation, which otherwise might have escaped detection until late in labor. Reference has already been made to its value in the diagnosis of pregnancy, and in the appropriate places its utilization in the recognition of multiple pregnancy and of fœtal deformity will be mentioned. A good review of its diagnostic possibilities was given by Portes and Blanche, in 1924.

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SECTION IV

PHYSIOLOGY OF LABOR

CHAPTER X

THE PHYSIOLOGY AND CLINICAL COURSE OF LABOR

By labor we understand the process which brings about the separation of the mature or nearly mature product of conception from the interior of the uterus, and its extrusion from the maternal organism, whether the birth occurs spontaneously or requires external aid.

Cause of the Onset of Labor.—From time immemorial inquiring minds have sought an explanation for the fact that labor usually ensues about two hundred and eighty days after the appearance of the last menstrual period, but thus far no satisfactory universal cause has been discovered. The following are among the most important theories which have been advanced as to its causation:

1. The growing irritability of the uterus, associated with an increase in the frequency and strength of the intermittent contractions.
2. Increasing distention of the uterus.
3. Dilatation of the cervix by the presenting part.
4. Increasing distention of the lower uterine segment, with pressure upon the neighboring nervous structures.
5. Changes in the decidua—loosening, thinning, and thrombosis.
6. Excess of carbon dioxide or lack of oxygen in the placental blood, acting on nervous centers.
7. Menstrual periodicity.
8. Anaphylactic action of fœtal blood.
9. Heredity and habit.
10. Senility of the placenta.
11. Physical and emotional causes.
12. Hormonic influences, or the circulation of fœtal metabolic products.

1. The increasing readiness with which the uterus reacts to stimulation during the later months of pregnancy affords abundant evidence of its growing irritability. The intermittent contractions, which occur at intervals throughout pregnancy, come on more frequently at this time, and occasionally with such intensity that it may be difficult, in the last few weeks before delivery, to distinguish between them and actual labor pains.

2. Since the time of Mauriceau it has been believed that the uterus, when distended up to a certain point, must begin to contract and attempt to empty itself, just as happens in the case of any other hollow viscus. This presumption is supported by the frequency with which premature labor occurs in hydramnion or twin pregnancies. On the other hand, extreme distention does not necessarily give rise to labor, as is shown by the cases of prolonged pregnancy which are associated with large children. Furthermore, Wieloch, who has measured the intra-uterine pressure in cases of hydramnion, by puncturing the uterus and connecting the canula with a manometer, found that it differed little, if at all, from that obtaining in normal pregnancy.

3. Galen supposed that labor resulted from gradual dilatation of the cervix, which was brought about by the pressure of the presenting part, and the view still has numerous adherents. That the condition of the cervix is not the sole factor is shown by the fact that occasionally considerable dilatation may exist for days or even weeks before the onset of labor.

4. Keilmann, Knüpffer, and Keiffer advanced the theory that the onset of labor was the result of the gradual formation of the lower uterine segment, with consequent pressure upon the surrounding nervous ganglia.

5. Naegele, Simpson, Scanzoni, and others believed that the decidua in the later weeks of pregnancy underwent fatty degeneration, which resulted in the partial separation of the ovum and its practical conversion into a foreign body, which then gave rise to uterine contractions. My investigations, however, show that such changes do not occur normally.

It is generally recognized that the septa, by which the glandular spaces of the spongy layer of the decidua are bounded, become progressively thinner in the later months of pregnancy, and some authorities assume that in the last few weeks they tend to rupture and thereby bring about more or less extensive separation of the ovum from the uterine wall. No conclusive evidence of such an occurrence has been adduced, and my experience, which is based upon the examination of a considerable number of pregnant uteri at or near term, indicates that it rarely occurs until the third stage of labor.

6. Brown-Séquard, in 1853, demonstrated that an excess of carbon dioxide in the blood led to energetic uterine contractions, and Wigger, in 1928, showed that the presence of 5 per cent of that gas in the inspired air is frequently followed by more vigorous contractions at the time of labor. However this may be, no one has adduced evidence of a sudden increase in the amount of carbon dioxide in the blood sufficient to give rise to labor at the appointed time; although Leopold and others have contended that the carbon dioxide content of the placental blood is markedly increased as a result of progressive thrombosis of the decidual vessels.

My own investigations, however, lead me to believe that such a contention is based upon uncertain foundations; for, while pronounced thrombosis may sometimes be demonstrated, it is lacking in most full-term uteri. On the other hand, it occasionally develops early in pregnancy without leading to its interruption. For these reasons, I believe that the last word has not yet been spoken concerning the striking vascular changes which occur in the decidua basalis.

Moreover, recent work tends to invalidate Brown-Séquard's conclusions. Blumreich holds that carbon dioxide has less effect upon the pregnant than upon the nonpregnant uterus, while Kurdinowsky and Kehrer contend that it does not give rise to contractions at all.

7. Mende, Tyler-Smith, Löwenhardt, Beard, and others believe that there is an increased tendency toward uterine contractions at the periods at which the menstrual flow should appear if the patient were not pregnant, and that these reach their acme at about the date of the tenth menstrual period and give rise to labor. Observations of this character point toward the possibility of an ovarian hormone being the efficient cause.

8. Von der Heide considers that the cause of labor should be sought in an anaphylactic reaction. In normal pregnancy he holds that fœtal substances are constantly gaining access to the maternal circulation, and give rise to the formation of definite antibodies. As term approaches, excessive quantities of the fœtal antigen enter the mother's blood, and in the anaphylactic reaction which ensues between it and the existing antibodies, substances are set free which give rise to labor. He claimed that in a certain proportion of cases labor would follow the intravenous injection of a few cubic centimeters of fœtal blood. Kolmer, however, was unable to confirm such statements in experiments upon guinea-pigs; and, in view of the general collapse of similar theories in connection with the production of eclampsia, it appears unlikely that anaphylactic shock plays any great part in the causation of labor.

9. Geyl and others are inclined to attribute the onset of labor at the usual time to the fact that Nature, after ages of experiment, has found the end of the tenth month to be the most suitable time. For when labor occurs at a much later period it is usually difficult and results in dead children, while at an earlier period puny children are born which usually perish soon after birth.

10. Eden and I have pointed out that the frequent occurrence of infarct formation in the placenta at term must be regarded as evidence of its senility, and as analogous to the atrophy of the chorion læve at an earlier period. Where these changes are marked the nutrition of the fœtus must be interfered with, and it is possible that certain of its metabolic products may result in stimulation of the uterine centers. At most this explanation is of only limited application and cannot be invoked for the great majority of cases in which infarct formation is only slightly developed.

11. It is also a well-known fact that excessive physical exercise, sudden jars or violence, as well as extreme mental emotion, such as grief and anger, may lead to the termination of pregnancy, but at most they can only be regarded as contributing causes.

12. Spiegelberg advanced the view that the onset of labor is due to fœtal rather than to maternal changes. He held that the maturing fœtus needs materials for its sustenance other than those furnished by the placenta, and that as a result of imperfect nutrition certain substances gain access to the maternal circulation, and in some way stimulate the uterus. Naturally such a belief is a

mere hypothesis, but as our knowledge has increased concerning the physiology of the uterine contractions, and particularly concerning the function of the hormones produced by certain of the endocrine glands, there is a greater and greater tendency to seek a "biological" explanation for the cause of labor.

In the first place, observations made in my clinic years ago show that radical changes in metabolism occur immediately before and at the time of labor, which in all probability stand in some causal relation to it. Thus, Slemons has shown that twenty-four hours or less before the onset of labor the output of nitrogen through the urine becomes considerably diminished, while at the same time a marked diuresis occurs, thus completely reversing the conditions which existed throughout the last months of pregnancy. Accordingly, if the urinary analyses were made at sufficiently frequent intervals, it might be possible to predict the approaching onset of labor before the appearance of clinical symptoms.

In order to determine the relation which these changes bear to the causation of labor, Slemons, at my suggestion, studied the metabolism of two pregnant women in whom labor was induced by the introduction of a bougie, and found that such changes were absent, or at least less pronounced than when labor occurred spontaneously. Such observations seem to indicate that at least two factors may be concerned in the production of labor. One occurs in spontaneous labor, and is associated with the process which gives rise to the alteration in metabolism; while the second is a purely mechanical irritation, which is not accompanied by such changes. The nature of the first factor is as yet unknown, but it seems probable that it must be some substance which circulates in the blood, and possesses the double function of altering the entire metabolism, as well as of stimulating the uterus directly or indirectly to efficient contraction.

Likewise, observations by Zangemeister, and Momm indicate that the onset of labor is preceded by radical changes in metabolism. They found if women are weighed daily during the last few months of pregnancy that they gain 55 or 60 grams each day until three or four days before the onset of labor, when they suddenly lose about 1000 grams—or as much as they had gained during the preceding two or three weeks. This phenomenon occurs so constantly as to enable them to predict the onset of labor several days in advance.

Following the observations of Sun in this clinic, and of Flury in Germany, it is generally recognized that excised strips of uterine muscle from nonpregnant, as well as pregnant, women, when suspended in oxygenated Locke's solution, will contract rhythmically for many hours. This can be noted from the last months of intra-uterine life until after the menopause, and occurs not only in freshly excised tissue but also in that which has been preserved in the ice-box for as long as seven days. In general, the contractions are stronger and occur at longer intervals during pregnancy. From these observations several facts have emerged: First, that automatic rhythmic contractions can occur independently of any central nervous control, and hence must be due to the presence of ganglia in the uterine wall, or must represent an inherent property of its muscle; second, that they probably correspond to the so-called Braxton Hicks contractions of pregnancy; and, third, that one of the fundamental points to be elucidated in connection with the causation of labor is to ascertain in what manner these painless contractions, which have no effect upon the dilatation of the cervix or the termination of labor, become converted into true labor pains, which do so. Unfortunately, we are as yet entirely ignorant concerning this point.

Furthermore, the observations of Kurdinowsky, and Kehrer, and of Kruieger and Offergeld demonstrate that labor may supervene and terminate spontaneously quite independently of any central nervous control, and without assuming the existence of central or spinal centers. The first mentioned investigators found in animals that the isolated pregnant uterus, perfused with Locke's solution, would empty itself in the usual manner; while Kruieger and Offergeld freed the uterus from all nerve connections, and found that labor would set in at the proper time and go on to a spontaneous termination.

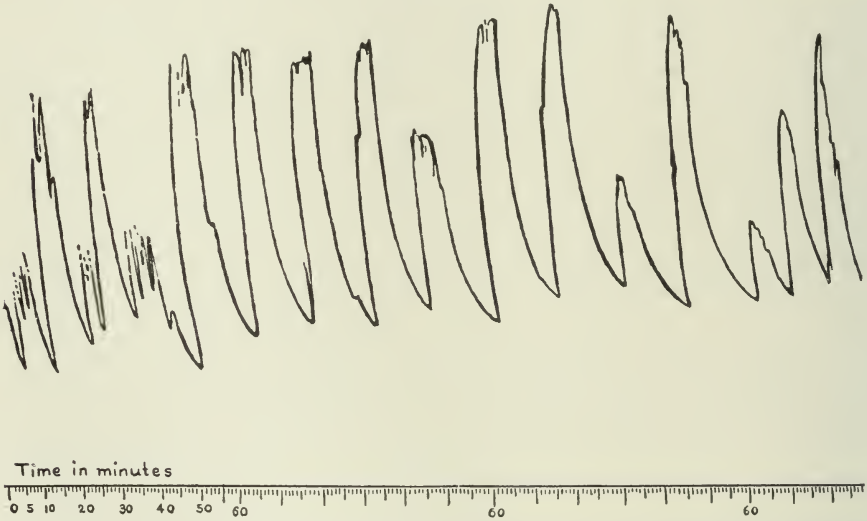

Fig. 223.—Spontaneous Contractions of the Excised Human Pregnant Uterus at Term (Sun).

As early as 1880, Rein showed that the transmission of impulses through the cord is not essential to the act of labor, and that the chief effect of severing the extrinsic nerve supply is to render the process painless. Moreover, the observations of Routh, Elkin and others show that in women who have sustained destructive injuries of the lower part of the spinal cord, labor usually progresses normally and painlessly, although expulsive efforts on the part of the abdominal wall may be lacking.

Consequently, it appears probable that the essential cause of labor must be sought in the circulation of some substance, which acts directly upon the uterine muscle, or so sensitizes it that it becomes susceptible to the action of some substance already present. In view of what has already been said it is probable that the central nervous system ordinarily exerts only a regulatory influence, or merely plays a part in the transmission of various reflexes. In this connection the observations of Whitehouse and Featherstone throw certain sidelights upon the question. They noted that when Cesarean section is performed under spinal anesthesia, that the circular fibers contract intensely, while the longitudinal fibers are lax. At the same time the cervix appears to become constricted. The French writers, on the other hand, while admitting the correctness of the first part of the statement, contend that the cervix and lower uterine segment tend to relax. For that reason they hold that spinal anesthesia is highly advantageous when forceps are to be applied, but is contra-indicated when version is contemplated. In any event, it would seem that the local anesthetic acts upon the portion of the spinal cord bathed by it, and, by paralyzing the parasympathetic supply to the uterus, permits the sympathetic system, as represented by the hypogastric nerve, to act without restraint.

It is also of interest to note that Sun observed that the rate of the rhythmic contractions of the excised uterus varies in different parts of the organ. Dividing its wall into three layers, he found that the rate is most rapid in the subdecidual layer, and slowest in the outer or subperitoneal layer, while the thick central layer contracts in an irregular manner and at variable rate.

When Sauerbrück and Heyde first published their results upon the effect of labor in symbiotic rats, it was thought that they afforded striking proof of the existence of some poisonous substance in the blood of the first rat to fall into labor, which was then transmitted to the sister rat. The subsequent work of Sauerbrück's pupil, Schmidt, as well as that of Kross, has tended to show that this occurs only when one rat is at a much more advanced stage of pregnancy than the other, and even then the latter is not usually affected.

From time to time in recent years, various writers have claimed that the injections into pregnant animals of various preparations made from the blood of parturient animals cause uterine contractions. Up to the present time, however, such results have been so contradictory that they must be regarded with great reserve. Following the discovery of the oxytocic properties of extracts prepared from the posterior pituitary lobe, it was promptly attempted to induce premature labor or abortion by its injection into pregnant women, whose condition required the termination of pregnancy. It was soon found that it was useless for the induction of abortion, but became more and more efficient for the induction of premature labor the nearer pregnancy approached term.

This question was put upon an experimental basis by Knaus, who showed in rabbits that early in pregnancy death results from pituitrin poisoning before the uterus shows any signs of activity, but that in the last few days of pregnancy labor can readily be induced by a dose one to two hundred times smaller than that which had been ineffectual a few days previously. In his first publication he was inclined to correlate the increasing efficiency of the drug with the increasing hypertrophy of the muscle fibers of the uterus. In his second publication, however, he attributed the muscular hypertrophy to the action of a placental hormone, and believes that the secretion of the corpus luteum renders the muscle fibers refractory to the action of pituitary extract. In the latter part of pregnancy, on the other hand, he holds that the inhibiting effect of the corpus luteum gradually diminishes with the result that the muscle fibers become more susceptible to the action of pituitrin. Whether Knaus' explanation is correct or not, it is highly suggestive and is in accord with clinical experience.

In 1928, Hofbauer raised the question as to why the uterus does not expel its contents early in pregnancy, as it does in the case of all other foreign bodies. He called attention to the supposedly physiological increase in the amount of bile acids circulating in the blood during pregnancy, and then performed some interesting experiments with excised strips of uterine muscle. In the nonpregnant animal he found that the addition of a small quantity of sodium glycocholate to the Locke's solution promptly brings about complete cessation of the automatic contractions, which can be restored by the addition of pituitary extract. As pregnancy advanced, however, he found that larger quantities of the bile salt are necessary to inhibit contractions, while a progressively smaller amount of pituitrin is required to restore contractions.

Whether this represents the normal course of events is doubtful, but the work of both Knaus and Hofbauer clearly shows that as pregnancy advances the uterine muscle becomes progressively sensitized to the action of pituitrin, and possibly to other substances, and makes it more and more probable that the solution of the problem will eventually be solved along "biological" lines.

In other words, it is probable that the ultimate cause of labor consists in some hormonic stimulation of the intrinsic ganglia of the uterus or of its muscle fibers themselves, and that certain of the so-called causes enumerated above may play a contributing part. If this proves to be correct, it is probable that it will eventually be found that the central nervous system has principally a regulative function, makes possible the perception of pain, and controls the voluntary abdominal contractions; while the sympathetic system regulates the vascular conditions.

Labor Pains.—With the onset of labor, the painless intermittent contractions which have persisted throughout pregnancy are replaced by others of increasing intensity, giving rise to severe pain, and bringing about the dilatation of the cervix and the expulsion of the child and placenta.

The uterine contractions, just as those of all other nonstriated muscles, are independent of the will of the patient, and can neither be increased nor diminished in frequency by her volition. But at the same time they may be affected by the emotions, and any sudden excitement may either check them or cause them to become more violent. Thus, it is a matter of common observation that the entrance of the obstetrician may be followed by a temporary lull in the intensity and frequency of the pains.

The contractions begin slowly, gradually reach an acme, and then gradually diminish in intensity, the active process being followed by a pause of some length. The tracings of Schatz and Polaillon show that the period of increase occupies the greater portion of the pain, and that its acme is of very short duration. In the lower animals which possess bicornuate uteri the contractions are distinctly peristaltic in character; and Schatz believes that such is also the case in human beings. It is important to bear in mind that labor pains are effective only during the period of increase, and that the tightly contracted organ is worthless from a mechanical standpoint.

These uterine contractions are nearly always accompanied by painful sensations, whence the term "labor pains," although the amount of suffering varies greatly in different individuals. The pain usually begins in the sacral region and then slowly passes to the abdomen and down the thighs. In the early stages of labor it is probably due to pressure upon the nerve-endings between the muscle fibers; but in the later stages it is augmented by the overstretching and dilatation of the soft parts, and becomes most marked when the head distends the vulva just before its birth. Usually the final pains are very severe, and may be almost insupportable, but occasionally the suffering is very slight, and, in rare instances, labor may be almost entirely painless, even though the patient be perfectly conscious. A number of such cases have been collected by Coliez and Wolff.

At the onset of labor the pains come on at intervals of from fifteen to thirty minutes; as it advances they gradually become more frequent, and eventually occur every two or three minutes. Their average duration is about one minute—thirty to ninety seconds—though suffering is not experienced during the entire contraction, as the hand placed over the abdomen may feel the uterus becoming hard for several seconds before the patient perceives the slightest pain.

Force Exerted by Labor Pains.—On this point there has been a good deal of misconception, and a tendency toward exaggeration appears in the writings of not a few authors. Thus Sterne, in *Tristram Shandy,* estimated that the force exerted at each pain during labor amounted to 470 pounds, while Professor Haughton put it at 577 pounds. Poppel, Duncan, Ribemont, and others have attempted to approximate it by determining the force necessary to cause the rupture of the membranes outside the body. This, they found, varied markedly, and in 100 experiments Duncan placed the extremes at 4 and 37.58 pounds respectively with an average of 16.73 pounds.

Joulin and other observers have attempted to solve the problem by calculating the force exerted in forceps deliveries. Thus, on interpolating a dynamometer between the operator and the handles of the instrument, it was found that the tractile force rarely exceeded 80, though in some cases it reached 100 pounds. A greater direct force than this cannot come into play, as it has been shown that one of 120 pounds is sufficient to tear the child's head from its body.

Schatz studied the subject by inserting into the uterus a rubber bag which was connected with a manometer. In this way he found that the intra-uterine pressure, in the intervals between the contractions, was represented by a column of mercury 20 millimeters high, 5 of which were due to the tonicity of the uterine walls and 15 to its contents. During the pains, however, the mercury rose to a height of from 80 to 250 millimeters, which corresponds to a force of 8½ to 27½ pounds. He also showed that the force exerted by the uterus increases markedly when the fœtus is partially expelled from it.

A rough idea may also be gained by estimating the expenditure of energy necessary to restrain the head as it emerges from the vulva. This rarely exceeds 50 pounds, although the obstetrician frequently finds it impossible to hold it back at the acme of a pain. This inability is in great part due to the disadvantageous manner in which one's energy is exerted, rather than to the actual force exerted.

Physical Changes during Uterine Contractions.—During contraction the uterus undergoes definite changes in shape. With the patient on her back, the organ in the flaccid state rests upon the vertebral column, and its tranverse equals or exceeds its vertical diameter. But when it contracts the uterus leaves the vertebral column, becomes more erect, pushes the anterior abdominal wall forward, and its long axis comes into approximation with that of the superior strait. At the same time the vertical increases at the expense of the transverse diameter (Fig. 224).

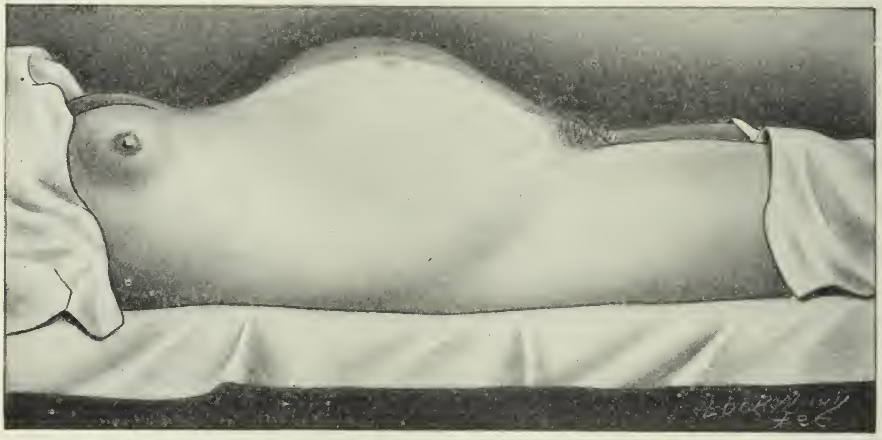

FIG. 224.—COMPOSITE PICTURE, SHOWING SHAPE OF ABDOMEN BEFORE AND DURING A UTERINE CONTRACTION, THE DARKER OUTLINES INDICATING CONTRACTION.

The dilatation of the cervix is usually brought about solely by the action of the uterine muscle, whereas during the expulsion of the child the muscles of the abdominal wall also come into play. During the second stage the patient braces her body against some fixed object, takes a deep inspiration, closes the glottis, and makes forcible straining movements with the abdominal and respiratory muscles. By these means the intra-abdominal pressure is markedly increased, and is transmitted directly to the uterus. At first these movements are voluntary, but as labor advances they pass beyond the control of the will, and may occur even with the patient under profound anesthesia.

The abdominal muscles, therefore, play an important part in the expulsion of the child, which in many instances makes no progress without their aid. The fact that spontaneous labors occasionally occur in women who are paralyzed from the waist down shows that their action is not indispensable in every case; but, on the other hand, the application of low forceps is frequently necessitated by the inability of the abdominal muscles to do their work, or to the unwillingness of the patient to bear the pain associated with their employment.

The various ligamentary structures connected with the uterus also take part in the contractions. Of these the most important are the round ligaments, which in contracting tend to draw the fundus of the uterus forward and to fix it in position. They can be readily palpated through the abdominal wall, and some idea of the intensity of the uterine contractions may be gained from their consistency.

The part played by the vagina during labor is almost entirely passive, and it is only after the expulsion of the child that the contraction of the muscular elements in its walls comes into play.

The general arterial tension is raised during the labor pains, as is indicated by the flushed look of the patient, as well as by the more accurate observations of Vaquez, and of Slemons and Goldsborough in my clinic. The pulse becomes accelerated during, and slower in the intervals between, the pains. It is also stated that the temperature rises a fraction of a degree during each pain, though its detection requires the employment of very accurate thermometers. Respiration becomes slower during the contractions, more rapid in the interval between them, and is totally abolished during the expulsive pains of the second stage of labor. My observations upon the respiratory exchange show that the consumption of oxygen and the output of carbon dioxide are increased during labor, but not to the extent one would suppose. As has already been stated, this probably indicates that the general oxidative processes of the body are reduced to a minimum at this time, and consequently that the actual work of labor is accomplished with comparatively less expenditure of energy than in the case of an equal amount of muscular exertion at other times.

Clinical Course of Labor.—Before taking up the consideration of the forces concerned in the expulsion of the fœtus and the mechanism by which it is accomplished, it is advisable for the student to follow as a spectator the course of parturition in a primiparous woman.

Several weeks before the onset of labor the abdomen undergoes a marked change in shape, its lower portion becoming more pendulous, whereas in the neighborhood of the costal margin it looks decidedly flatter. This change is perceived by the woman herself, who feels that her waist has become lower; and occasionally it occurs so suddenly as to cause her to fear that something has given way inside the abdomen. Abdominal palpation shows that the change is due to the fact that the fundus of the uterus has descended from the position which it occupied at the ninth month, and resumed that of the eighth, and that the head, which was previously freely movable, has become fixed in the superior strait. These changes are most pronounced in primiparæ, and frequently do not occur in multiparæ until the onset of labor.

After this the patient experiences considerable relief from the respiratory disturbances from which she may have suffered; but at the same time locomotion may become more difficult, and she may suffer from severe cramplike pains in the lower extremities and a more frequent desire to urinate.

During the last few weeks of pregnancy the vaginal secretion is increased in amount, the labia become more swollen and succulent, and in multiparæ gape more or less widely, while the patient may experience a few transient pains for a number of days before confinement, the so-called "dolores præsagientes."

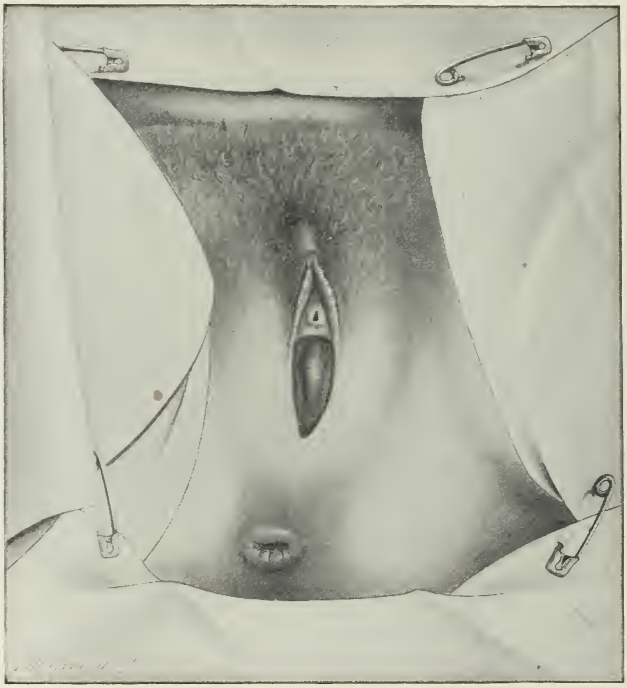

Fig. 225.—Birth of Head, Scalp Appearing at Vulva.

For purposes of description, labor is divided into three stages: The first, or period of dilatation, extends from the commencement of labor until the cervix is completely dilated; the second, or period of expulsion, extends from the complete dilatation of the cervix to the birth of the child; while the third stage, or placental period, lasts from the birth of the child to the extrusion of the placenta.

First Stage.—About the end of the tenth lunar month the patient begins to experience cramplike pains in the lower portion of her abdomen, which she sometimes mistakes for intestinal colic. At first these sensations recur only at long intervals, but soon are felt more frequently. They are most marked in the lumbar region and gradually extend toward the abdomen and down the thighs. As the pains become more frequent they likewise increase in severity, and in the latter part of the first stage the patient may complain bitterly, and often seeks to ease herself by making pressure over the sacral region.

The result of the pains in this stage of labor is to bring about the dilatation of the cervix, and, as it slowly yields to the pressure of the amniotic fluid contained within the membranes, slight lesions occur about its margins, which are manifested by a small admixture of blood with the vaginal discharge—the *"show."* During this period the patient is perfectly comfortable between the pains, and for a time can attend to her ordinary avocations; but, as the pains become more severe, she assumes a sitting or leaning posture, and frequently gives utterance to short, sharp, querulous cries.

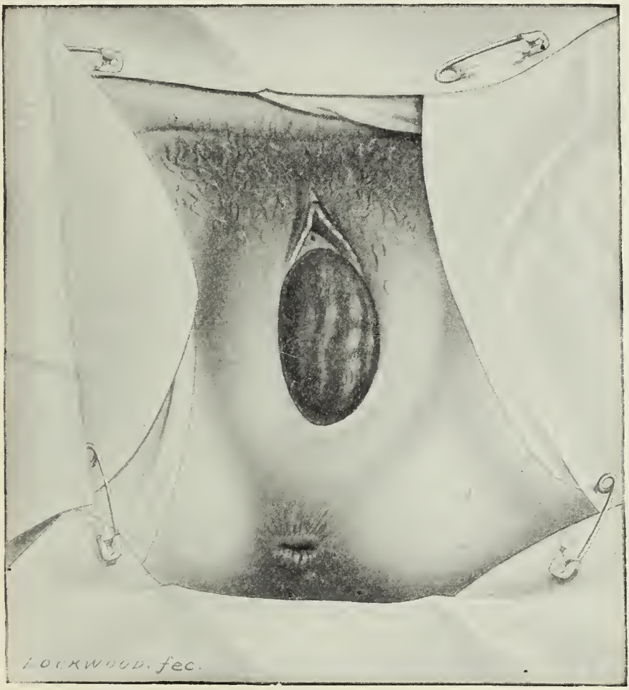

Fig. 226.—Birth of Head, Vulva Partially Distended.

After the pains have continued for from twelve to fifteen hours, more or less, there is a sudden gush of clear fluid from the vagina, which usually indicates that the cervix has become completely dilated, and that the membranes, having fulfilled their function as a hydrostatic wedge, have ruptured. The amount of fluid which escapes varies according to the situation of the point of rupture and the position of the presenting part. In vertex presentations, where the pelvis is normal, the cervix is tamponed, so to speak, by the rounded head, and only a small portion of liquor amnii escapes. On the other hand, if the head be not engaged, or if there be some disproportion between it and the pelvis, the entire amount of amniotic fluid may escape. But even in perfectly normal cases a small quantity escapes with each pain.

In a certain proportion of cases the membranes rupture before complete dilatation of the cervix. In such circumstances further dilatation must be effected by pressure exerted by the presenting part, and, as it fills out the cervix less completely and accurately than the bag of waters, the process proceeds more slowly. These are instances of what are commonly known as *dry labors.* When the rupture occurs before the onset of labor, pains ordinarily set in within twenty-four hours, but exceptionally, several days or even a week or longer may elapse, so that in such cases one should be cautious in expressing an opinion as to when labor will begin. Meyer-Ruegg, in 1904, collected from the literature 15 cases in which several months elapsed between this occurrence and the completion of labor, though so long an interval is very unusual.

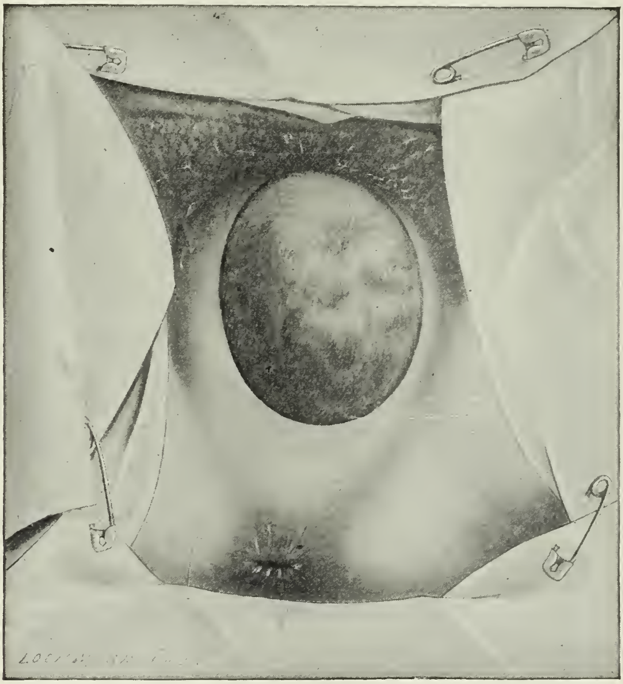

FIG. 227.—BIRTH OF HEAD, VULVA COMPLETELY DISTENDED.

Second Stage.—For a short time after rupture of the membranes there is a lull in the labor pains, after which they recur with increasing frequency and vigor, and compel the patient to take to her bed, where if left to herself she usually assumes a crouching or squatting posture. During this period the abdominal muscles are brought into play. At first the patient, with each uterine pain, may cause them to contract by an effort of her will. Later, however, this becomes involuntary, and she is usually unable to resist bearing down. At the onset of the pain she braces her feet against some solid object, takes a deep inspiration, and brings her abdominal and respiratory muscles into active play, her efforts being accompanied by a characteristic grunting sound. At the same time her face becomes congested, and in the later stages of labor covered with sweat. As the pain passes off, the glottis is opened and respiration reëstablished, the same phenomena being repeated as soon as another contraction comes on.

It is during this period that the child passes through the pelvis. After expulsive pains have continued for about an hour the patient frequently experiences a desire to go to stool, which indicates that the head has descended deeply into the pelvic cavity and is pressing upon the rectum. In a short time the pelvic floor may be seen to bulge with each pain, and a little later the scalp of the fœtus may be detected through the slitlike vulval opening. With each subsequent pain the perineum bulges more and more, and the vulva becomes more and more dilated and distended by the head, being gradually converted into an ovoid, and at last into an almost circular, opening. With the subsidence of each contraction, it becomes smaller and the head recedes from it, to advance again with the next pain.

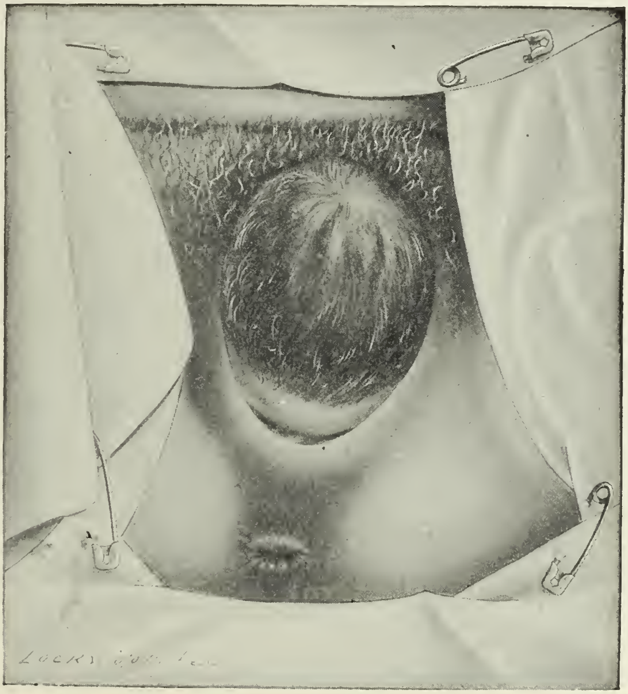

FIG. 228.—BIRTH OF HEAD, SHOWING DELIVERY BY EXTENSION.

As labor progresses the perineum becomes still more distended and thinner, especially in its anterior portion; so that eventually its frenulum does not exceed a piece of paper in thickness, and looks as if it would rupture with each pain. At the same time the anus becomes greatly stretched and protuberant, and the anterior wall of the rectum may protrude through it. By this time the perineum has become converted into a deep gutter, 5 to 6 centimeters long, at the end of which is the vulval opening, which looks almost directly upward and is distended by the head of the child, whose occiput is firmly pressed against the symphysis pubis. The distention of the vulva is most marked at its perineal margin, and less so at its upper and lateral portions.

The head advances a little with each pain and recedes in the intervals between them. This continues until the parietal bosses become engaged in the vulva, when further recession becomes impossible, and with the next two or three pains the head is rapidly expelled by a movement of extension, the base of the occiput rotating around the lower margin of the symphysis pubis as a fulcrum, while the bregma, brow and face successively pass over the fourchet. In the majority of primiparæ the perineum is unable to withstand the strain to which it is subjected, and tears in its anterior portion, though usually only to a slight extent.

Immediately after its birth the head falls backward, so that the face comes almost in contact with the anus. In a few moments the occiput turns toward the one or other thigh, and eventually the entire head assumes a transverse position. This is known as external rotation or restitution, and indicates that the bisacromial diameter of the child has rotated into the anteroposterior diameter of the pelvic outlet.

At this time the perineum is quite tightly retracted around the neck of the infant, whose face in consequence may become so congested that the inexperienced obstetrician is often seized by an almost uncontrollable desire to complete delivery by traction upon the head. This, however, is usually unnecessary, for the next pain forces the anterior shoulder down under the symphysis pubis, where it becomes fixed; while the posterior shoulder emerges over the anterior margin of the perineum, after which the body of the child is rapidly expelled by a movement of lateral flexion, following a curve corresponding to the axis of the birth canal.

Immediately after the extrusion of the child comes a gush of amniotic fluid, which represents the portion which did not escape when the membranes ruptured, and which may be more or less tinged with blood.

In primiparous women the second stage of labor usually lasts about two hours, but is much shorter in multiparous women, in whom two or three pains sometimes suffice for the completion of the period of expulsion.

Third Stage.—For a few minutes after the birth of the child there is a cessation of the uterine contractions, and the patient experiences a profound sense of relief. On glancing at the abdomen it is seen that the uterus has become much smaller and forms a firm, solid tumor whose upper margin lies well below the umbilicus. After a longer or shorter period the uterine contractions commence once more, and a few moments later the fundus of the uterus may be seen to rise up for several centimeters, while a slight tumefaction appears immediately above the symphysis pubis (see Figs. 323 and 324). This indicates that the placenta has become separated from the interior of the uterus and is now in the lower uterine segment or the upper portion of the vagina. From this position it is expelled by the action of the abdominal muscles, the time varying according to the efficiency of their contraction. Occasionally the entire placental period may be terminated spontaneously within a few minutes after the birth of the child, but more frequently the placenta will remain in the lower uterine segment until forced from it by proper manipulation on the part of the obstetrician.

During the third stage there is nearly always a moderate amount of bleeding, which in normal cases does not exceed 600 cubic centimeters, and is usually much less—250 to 300 cubic centimeters being the most usual amount of blood lost. Frequently the patient may have a chill during this period, or immediately after its completion. This, although it may appear somewhat alarming, in itself has no significance as it is merely a vasomotor phenomenon, and is not indicative of infection.

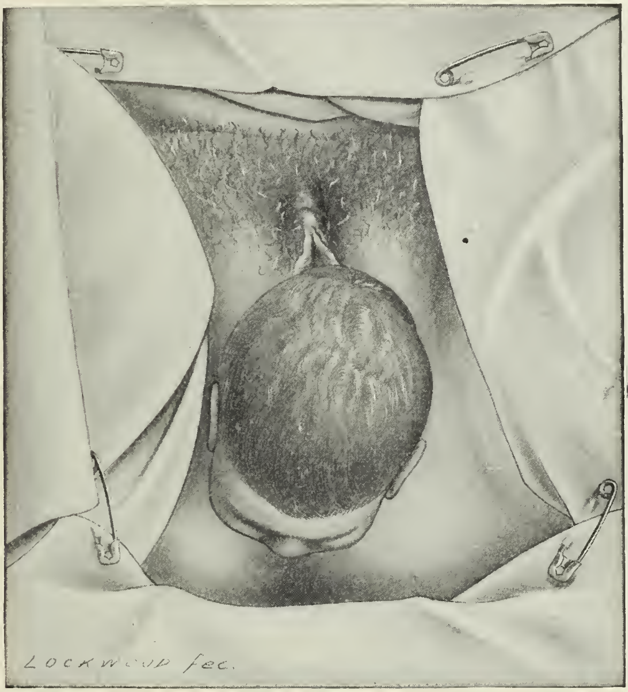

FIG. 229.—BIRTH OF HEAD, FACE FALLING BACKWARD TOWARD ANUS.

Duration of Labor.—The duration of labor presents considerable individual variations, and is usually about six hours longer in primiparæ than in multiparæ. Generally speaking, the average for the former is about eighteen hours, of which sixteen are occupied by the first, one and three-quarters to two by the second, and a quarter to a half hour by the third stage of labor; for the latter it is about twelve hours, eleven of which are occupied by the first, and one by the second stage. The slower course of labor in the former is due to the greater resistance offered by the soft parts. Occasionally labor may be extremely rapid, and even in primiparæ the entire process is sometimes completed within a few hours; while, on the other hand, a duration of twenty-four to thirty-six hours or even longer is not unusual.

Contrary to the general belief labor is exceptionally rapid and easy in very young primiparæ. Harris, after analyzing the histories of 500 such cases in our service, reached the conclusion that, from a purely obstetrical point of view, sixteen years or less represents the optimum age for the birth of the first child —a view which is stared by Gache, and Bondy. On the other hand, labor is usually definitely prolonged in elderly primiparæ—that is, after the thirtieth year. According to Ahlfeld, it exceeds the average by seven hours, though Varnier states that the difference is much less. At the same time the latter author points out that forceps are much more frequently required in old than in young primiparæ, being applied in 25 per cent and 1.6 per cent of his cases respectively, thus indicating that labor would have lasted much longer had it not been terminated by operative means.

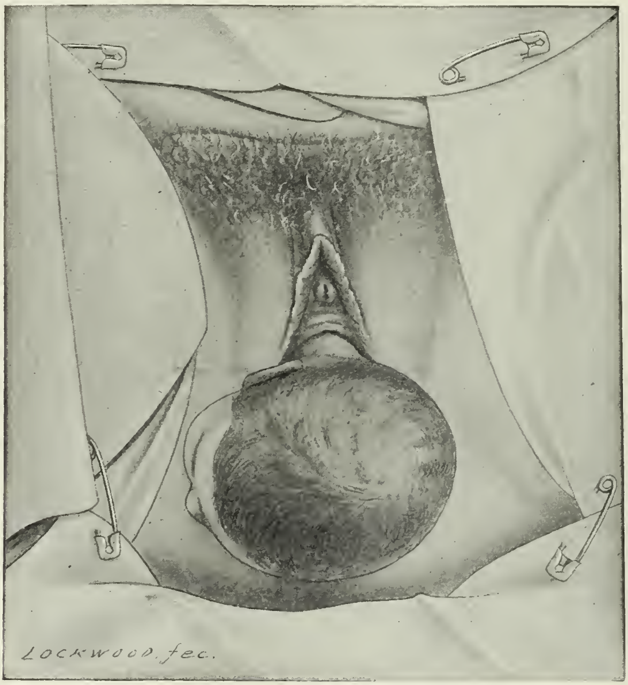

Fig. 230.—Birth of Head, External Rotation.

It is generally stated that delivery occurs most frequently between the hours of 2 and 4 A.M. Observations by Lynch in my service, as well as the statistics of Knapp, which are based upon 39,000 cases, show that this is not correct, and that more children are born between 9 and 12 P.M. than in any other three hours of the day. Furthermore, if the day be divided, according as delivery occurs in the twelve hours preceding or following 6 P.M., respectively, it will be found that only 4 or 5 per cent more children are born in the latter than in the former period. The general belief that most births occur at night is due to the fact that labor usually lasts more than twelve hours, and accordingly either its beginning or end must necessarily fall between 6 P.M. and 6 A.M.

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CHAPTER XI

THE FORCES CONCERNED IN LABOR

The Cervix in the Later Part of Pregnancy.—On vaginal examination in the later months of pregnancy, the cervix is found to be much softer and somewhat broader than in the nonpregnant condition. At the same time it usually gives the impression of being considerably shortened, especially in its anterior portion. This condition led Mauriceau, Roederer, and nearly all of the earlier authorities to believe that from the fifth month onward the upper portion of the cervix gradually became obliterated and contributed to the enlargement of the uterine cavity, that which was left at the end of pregnancy representing merely its inferior end.

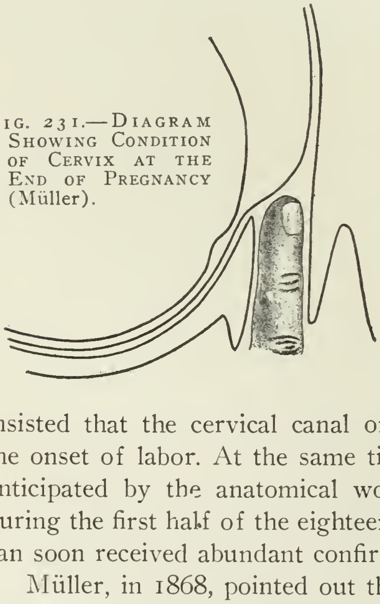


Fig. 231.—Diagram Showing Condition of Cervix at the End of Pregnancy (Müller).

Stoltz, in 1826, stated that the shortening was only apparent, being brought about by a fusiform dilatation of the cervical canal which resulted in the approach of the internal to the external os. He believed that the cervix retained its integrity until about two weeks before the onset of labor, when the canal slowly became obliterated and came to form part of the uterine cavity. Matthews Duncan amplified these views in 1868, but insisted that the cervical canal ordinarily remains practically unchanged until the onset of labor. At the same time, he pointed out that such views had been anticipated by the anatomical work of Verhegen, de Graaf, and Weitbrecht during the first half of the eighteenth century. The teachings of Stoltz and Duncan soon received abundant confirmation and are now generally accepted.

Müller, in 1868, pointed out that the apparent shortening of the cervix was due to the anteflexion of the uterus, as well as to the depression of the anterior fornix of the vagina by the presenting part, to which should be added the increased succulence of the entire genital tract. He also stated that the finger, at the end of pregnancy, could be introduced into the canal for a distance of 2.5 to 3 centimeters before it was arrested by the internal os.

The investigations of Stieve, to which reference was made in Chapter VI, however, show that the cervix during pregnancy undergoes radical changes, which consist essentially in a wonderful proliferation of the mucosa lining its canal, in so great a development of the blood vessels in its outer walls as to form an almost erectile tissue, in a transformation of its connective tissue into a more juvenile type, as well as in a relative diminution in the number of muscle fibers. As a result, the cervix usually becomes more voluminous and considerably softer, so that its canal readily admits the fingertip, which can usually pass up to, but not through the internal os.

In recent years the results obtained by examination during life have received additional confirmation from the study of frozen sections made through the bodies of women dying late in pregnancy. Valuable contributions along these lines have been made by Waldeyer, Schroeder, Braune and Zweifel, Pinard and Varnier, Leopold, and others.

Lower Uterine Segment.—For a short time after the appearance of Müller's work, the question concerning the behavior of the cervix was regarded as practically settled; but these hopes were shattered in 1872 by the studies of Braune upon frozen sections made through a woman who had died during the second stage of labor. His specimen showed distinctly that the interior of the uterus was divided into two parts by a projecting circular ridge, 10 to 11 centimeters above the margins of the dilated external os, its situation being marked by a large vein, and by the deflection of the peritoneum from the anterior surface of the uterus (Fig. 235). The portion above the ridge possessed thick walls, while the remainder formed a thin-walled, muscular tube through which the head had partially passed. Braune identified this ring or ridge with the internal os, and concluded that everything below it had been derived from the cervix; nor did he think it remarkable that the small canal

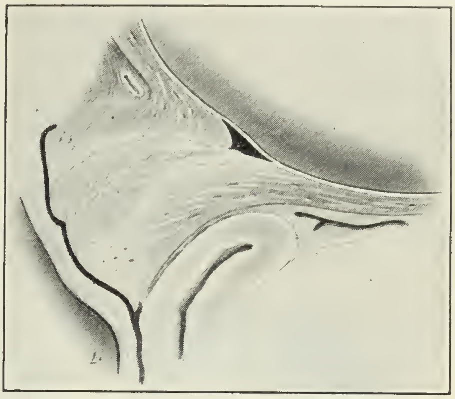


Fig. 232.—Cervix at the End of Pregnancy (Waldeyer). × ½.

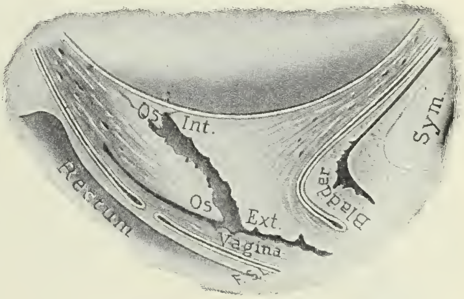


Fig. 233.—Cervix at the End of Pregnancy (Braune and Zweifel). × ½.

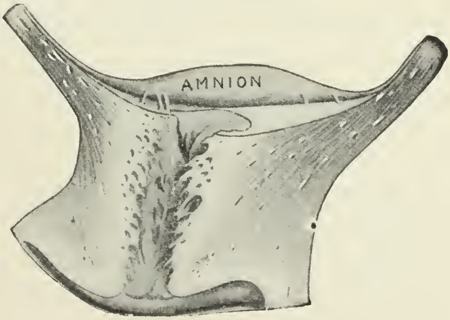


Fig. 234.—Cervix at the End of Pregnancy, Showing Preservation of Canal (Leopold). × ½.

which had existed up to the time of labor should have been converted into a structure of such dimensions.

Bandl, in his work upon rupture of the uterus, which appeared in 1875, pointed out that when such an accident occurs the site of rupture is nearly always situated below Braune's ring—namely, in the *lower uterine segment.* When he took up the subject the following year, he considered it inconceivable that the cervical canal, which was only 2.5 to 3.5 centimeters long at the end of pregnancy, could be converted in a few hours into the structure described by Braune. He therefore concluded that, if the upper boundary of the latter really represented the internal os, certain preparatory modifications must have taken place during the later part of pregnancy in order to make such a change possible. He believed that, during the last few weeks of pregnancy, the tissue forming the outer portion of the cervix had gradually shifted, so that it became incorporated into the musculature of the lower portion of the body of the uterus, while the cervical mucous membrane retained its original position. According to his view, then, the true internal os was situated not at the upper termination of the cervical mucosa, but much higher, and at a level corresponding to that of Braune's ring.

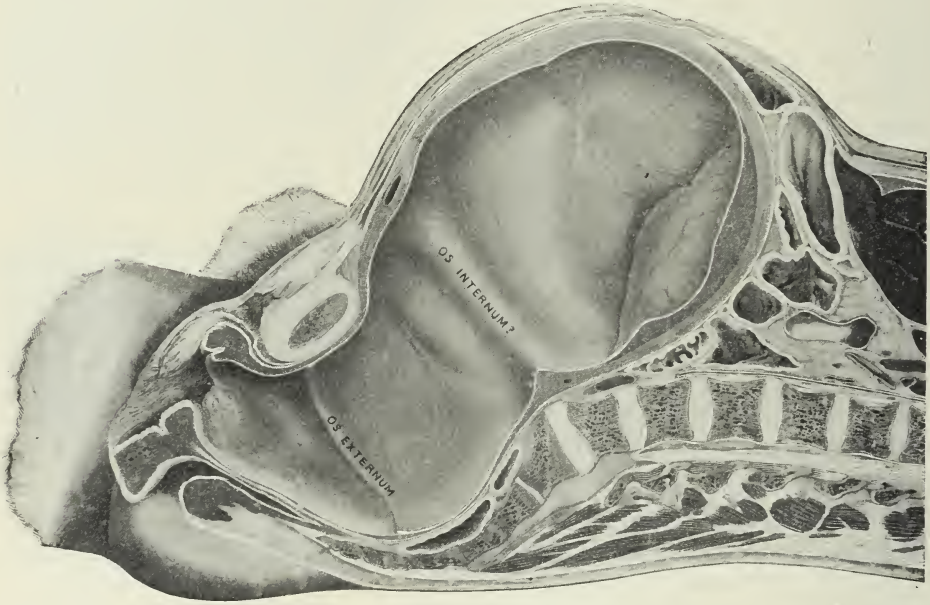


Fig. 235.—Frozen Section Made through Woman Dying during Second Stage of Labor, Showing Contraction Ring (Braune).

Although Bandl's complicated explanation is no longer accepted, his name will always have a place in obstetrical literature. More particularly, are we indebted to him for our views concerning the clinical significance of the lower uterine segment, inasmuch as he was the first to distinguish clearly between the function of the upper contractile and active and of the lower passive segments of the uterus, as well as the relation which they bear to the occurrence of rupture.

The discussion started by Bandl has been responsible for an immense literature, in which it is rare to find contributions which do not exceed fifty pages in length. Two main views have been advanced concerning the nature and origin of the passive segment of the uterus. According to the first, it is derived partly from the cervix, the internal os being supposed to be situated 3 or 4 centimeters above the external, while the rest of the structure—the lower uterine segment—is formed by the lower portion of the body of the uterus. According to the second view, the entire structure, from the external os to Braune's ring, is derived entirely from the cervix. The first view has received the indorsement of such authorities as Schroeder, Ruge, von Franqué, Barbour, Veit, Zweifel, Schmidt, and Stieve, while the correctness of the second explanation is upheld by Bandl, Küstner, Bayer, Gräsel, and Bumm and Blumreich. Fortunately, however, as will be indicated below, the question can now be regarded as definitely settled in favor of the former view.

At first glance it might appear strange that the question has given rise to such divergence of opinion, as it would seem a very simple matter to demonstrate the structure of the parts by microscopical examination. If the first view be correct, the inner surface of the portion which is supposed to be derived from the body of the uterus should be lined by decidua, and the portion below it, corresponding to the cervical canal, by the characteristic cervical mucosa. On the other hand, if the second explanation is to be accepted, the entire structure below Braune's ring—*the contraction or retraction ring,* as it is variously designated—should be lined by cervical epithelium.

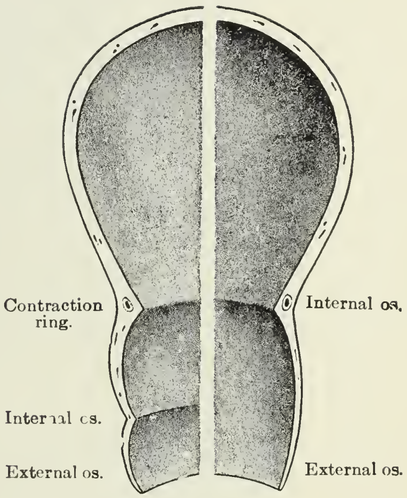


Fig. 236.—Diagram Illustrating Main Views as to Nature of Lower Uterine Segment (American Textbook).

Unfortunately, the question is not so easily solved. In the first place, the formation of the structures in question is in great part a clinical phenomenon; and while the situation of the contraction ring can usually be definitely made out by the examining finger during labor, it is not so clearly marked after the removal of the uterus from the dead body. Again, many of the specimens which have been relied upon to settle the question were utilized for frozen sections before being subjected to microscopical examination, so that the finer histological details had become obliterated. In spite of these obstacles, however, the question has gradually approached a solution, and it is now generally held that the lower uterine segment is derived from the isthmus of the uterus, while the cervix, apart from the changes already referred to, undergoes but little alteration.

After Aschoff, in 1906, had described the isthmus uteri, the problem began to be clarified, and eventually the answer to it was found in the study of uteri from early pregnancy, instead of at the time of labor. As was stated in the section on the nonpregnant uterus, Aschoff pointed out that a narrow canal 7 to 10 millimeters in length is interpolated between the cavity of the body of the uterus and the cervical canal, and is lined by a thin mucosa which is similar in structure to the endometrium, but differs somewhat from it in function. Before this differentiation had been established, considerable confusion existed as to the exact location of the internal os, some authorities placing it at the upper end of the isthmus and others at the upper end of the cervical canal. Aschoff solved

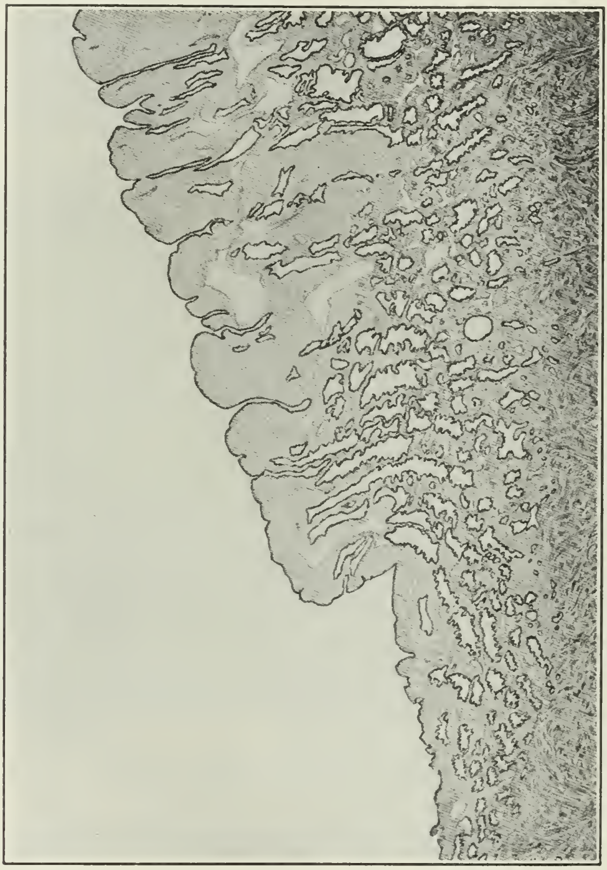


Fig. 237.—Section Showing Difference Between Mucosa of Body and of Lower Segment of 2 Months Pregnant Uterus (Stieve). × 10.
Upper thick part—body. Lower thin part—lower uterine segment.

this difficulty by designating the former as the anatomical and the latter as the histological internal os, and by pointing out that the canal between the two—the isthmus—is really a part of the body of the uterus.

Nürnberger has shown that the lining of the isthmus takes but little part in the menstrual process, while Schmidt and Stieve have demonstrated that early in pregnancy its mucosa undergoes the same type of change, but to a lesser degree, as that of the body of the uterus, and is sharply differentiated from that of the cervical canal. During the first months of pregnancy the isthmus is preserved as a tubular canal, but from the third month onward it becomes unfolded to form the lower pole of the uterine cavity. Even after fusion with the decidua capsularis, it remains thinner than the rest of the decidua, while its musculature is also thinner than elsewhere with its fibers arranged in more or less parallel rows.

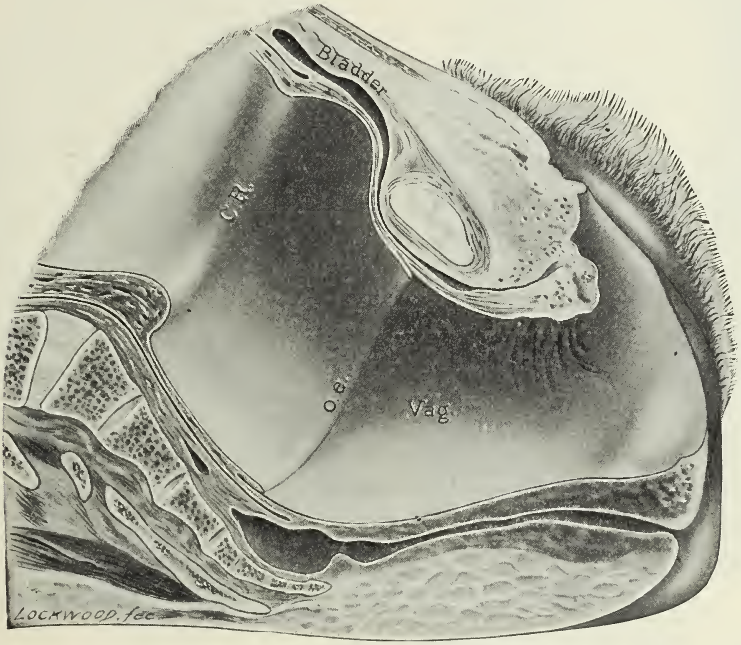


Fig. 238.—My Frozen Section, Showing Condition of the Birth Canal in First Part of Second Stage of Labor. × ½.
CR., contracting ring; *o.c.*, external os.

These findings, which I am able to confirm by my own experience, are so conclusive that I do not hesitate to teach that the lower segment is derived from the isthmus, and that the passive segment of the uterus at the time of labor has a double origin, its upper part representing the isthmus and its lower part the dilated cervical canal. For these reasons, I agree with the contention of Veit and of Zweifel, who, at a symposium before the Leipzig Obstetrical Society in 1914, urged that the discussion be ended by designating the isthmus in the nonpregnant as well as in the pregnant uterus, as the lower uterine segment.

Plate IX represents a vertical mesial through the uterus of a woman, seven months pregnant, who died at the Johns Hopkins Hospital during premature labor. In this it is clearly seen that the external os is not dilated, but that the cervical canal has become obliterated and a distinct lower uterine segment has been formed. Careful examination shows that the latter is lined with a typical cervical mucous membrane for a distance of 3.5 to 4 centimeters from the margins of the external os, whereas above this point its lining is composed of decidua.

Figure 238 represents part of a frozen section through a pregnant cadaver, shown in Plate I, which was kindly placed at my disposal by J. Holmes Smith and L. E. Neale. The woman, who had a generally contracted rachitic pelvis, died undelivered, with the child presenting by the breech and with the membranes protruding from the vulva. The cervical canal was obliterated and the external os fully dilated, its margins being 1 millimeter thick. There was no trace of the internal os. Seven centimeters above the external os was a well-marked contraction ring. Unfortunately, the specimen was so macerated that the lining membrane of the cervical canal and lower uterine segment had disappeared. Microscopical examination revealed only a few cervical glands in the neighborhood of the external os.

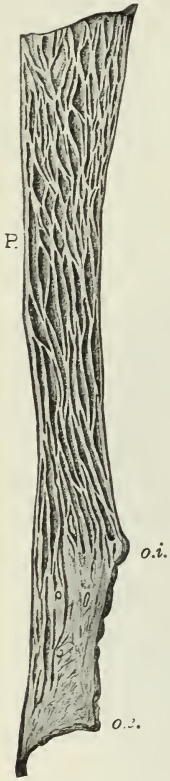
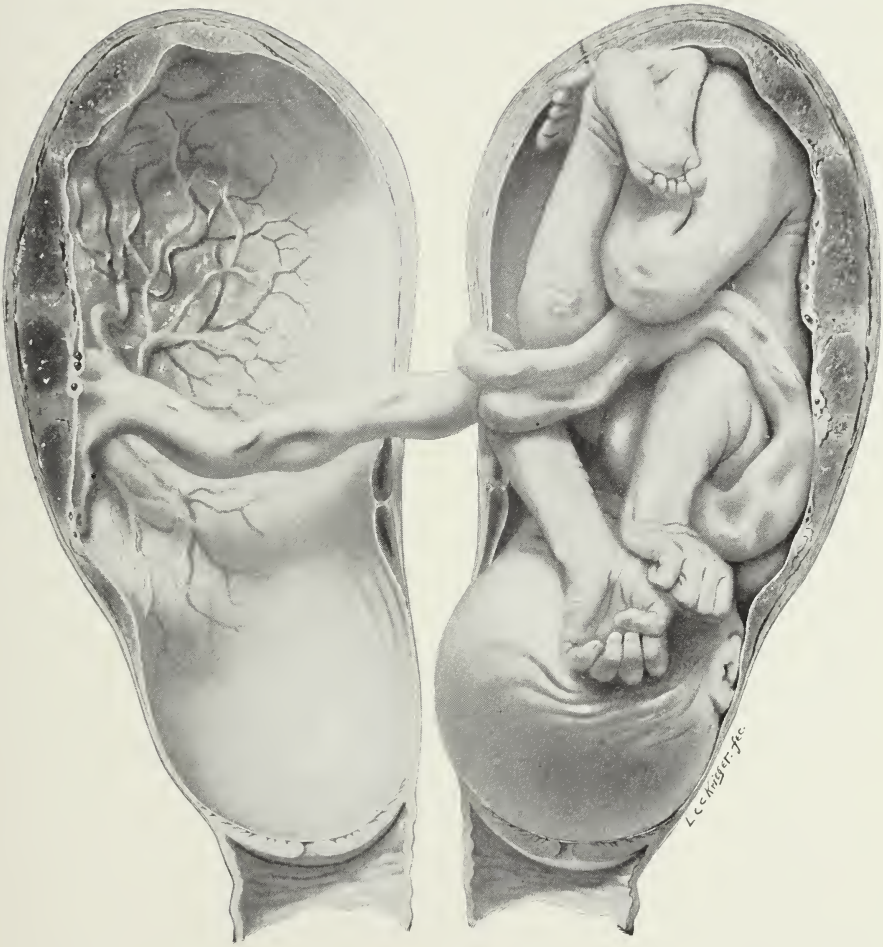


Fig. 239.—Section through Lower Uterine Segment and Cervix, Showing Rhomboidal Arrangement of Muscle Fibers in Former and Dense Structure in Latter (Hofmeier).
P., peritoneal covering of uterus; *o.e.*, os externum; *o.i.*, os internum.

Hofmeier, in 1886, demonstrated that the structure of the lower uterine segment is not homogeneous, and that the portion which corresponds to the cervix is composed in great part of dense connective tissue rich in elastic fibers, while its upper part is made up of muscular lamellæ which pursue an almost parallel course, whereas as soon as the contraction ring is reached the uterine musculature takes on its characteristic appearance.

Changes in the Uterus during the First Stage of Labor.—Passing from these more or less theoretical considerations to the condition of the uterus at the end of pregnancy, we find that the organ is made up of two parts; a large, thin-walled, muscular sac—the body—to the lower end of which the small cervix is attached. The uncontracted wall of the former, including the decidua and fœtal membranes, rarely exceeds 7 millimeters in thickness. The cervix is softened and succulent. It usually presents a fusiform canal, 3 to 4 centimeters long, filled with thick, tenacious mucus, and is bounded at its upper end by the internal and its lower end by the external os; its walls rarely exceeding 1.5 centimeters in thickness. Occasionally, however,

PLATE IX.


L C Krieger. fec.

SEVEN AND A HALF MONTHS' PREGNANT UTERUS FROM WOMAN DYING IN THE FIRST STAGE OF LABOR. × ½.

the resistance of the internal os has yielded, so that the upper part of the cervical canal has become continuous with the uterine cavity. The condition of the external os varies in primiparous or multiparous women. In the former it barely admits the tip of the finger; while in the latter it is widely gaping, so that the index finger can be readily passed through the funnel-shaped cervical canal up to, and sometimes through, the internal os.

During labor, under the influence of the uterine contractions, the uterus gradually becomes differentiated into two distinct portions, which are separated from one another by the contraction ring. The upper is the active contractile portion and becomes thicker as labor advances, while the lower, together with the cervical canal, plays a passive part, becoming converted into a thin-walled muscular tube for the transmission of the fœtus (Fig. 241). On abdominal palpation, even before the rupture of the membranes, two zones can sometimes be differentiated during a contraction, the upper one being firm and hard, while the lower affords a semifluctuant sensation. The former represents the contractile portion of the uterus, the latter the distended passive portion.

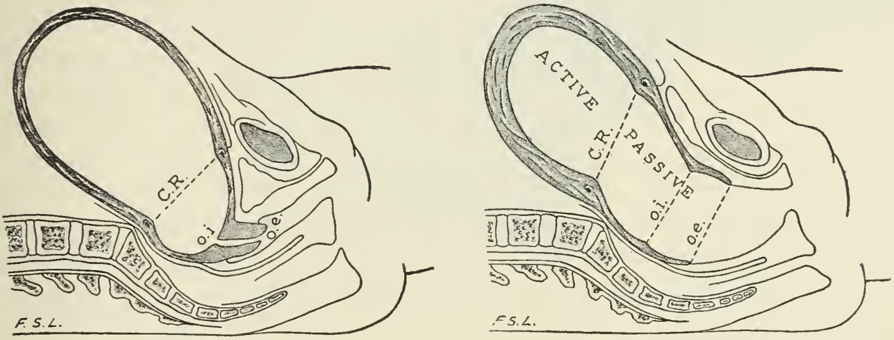


Fig. 240. Fig. 241.

FIGS. 240, 241.—DIAGRAMS OF BIRTH CANAL AT END OF PREGNANCY AND DURING SECOND STAGE OF LABOR, SHOWING FORMATION OF BIRTH CANAL (Schroeder).

With the onset of labor pains the fluid contents of the uterus are subjected to pressure, and the force exerted upon the liquor amnii is transmitted equally in all directions. As the lower uterine segment and the cervix will naturally constitute a point of least resistance, they are consequently subjected to an increased tension and distention.

Again, since the cervix is perforated by its canal, the fluid pressure exerted by the bag of waters tends to cause its obliteration and final dilatation, which is aided by the traction exerted upon its margins by the contracting fibers of the upper portion of the body of the uterus. Moreover, Stieve has clearly shown that when the so-called "mucous plug" is expelled early in labor, it carries with it practically the entire honeycomblike cervical mucosa, with the result that a relatively wide canal is exposed to the action of the dilating forces. Furthermore, dilatation is facilitated by the expression of blood from the erectilelike tissue of the outer walls of the cervix. When complete dilatation has been effected, the external os is about 10 centimeters in diameter, and its margins lie 7 to 10 centimeters below the contraction ring, while all trace of the internal os has disappeared. At the same time the bladder is gradually drawn up in front of the lower uterine segment until it becomes almost entirely an abdominal organ.

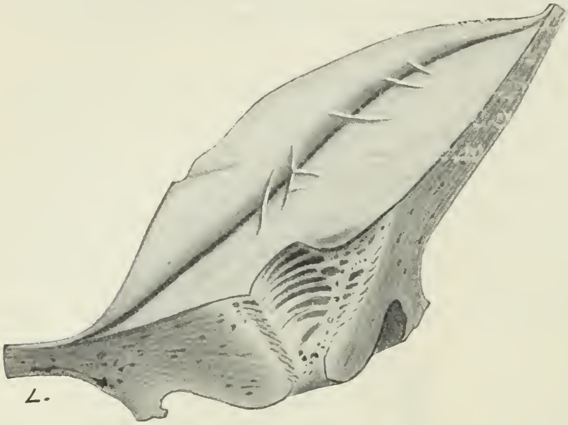


Fig. 242.—Dilatation of Cervix, Funnel-shaped Obliteration of Internal Os and Cervical Canal (Leopold).

The *dilatation of the cervix* should be regarded as consisting of two stages: first, obliteration of the canal; and, second, dilatation of the external os. The obliteration occurs from above downward, the beginning being indicated by a funnel-shaped depression at the region of the internal os, which gradually increases in extent and depth until the entire canal has disappeared, when the uterine cavity is separated from the vagina merely by the external os. This is clearly shown in Figures 242, 243 and 244.

After the cervical canal has become obliterated, dilatation of the external os occurs. In many instances its margin becomes extremely thin, and when tense gives a sensation as if it might cut the examining finger. These changes are brought about almost entirely by the force exerted by the bag of waters, or, when that has ruptured prematurely, by the pressure exerted by the presenting part itself.

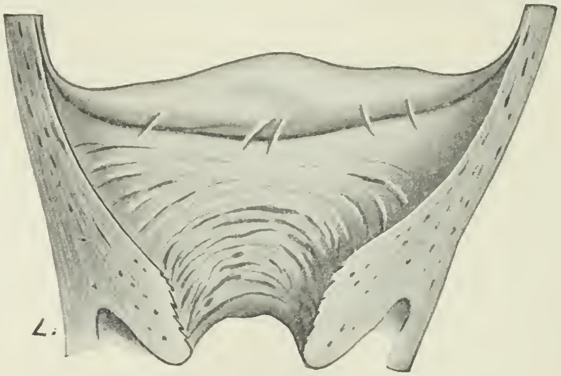


Fig. 243.—Dilatation of Cervix Further Advanced than in Fig. 242 (Leopold). × 1.

The course of events differs considerably according as the woman is in her first or a subsequent pregnancy. In the former case marked resistance is offered by the external os, and a considerable time must elapse before complete dilatation is accomplished; whereas in the latter, the os is gaping and very little force is required for its complete dilatation after the cervical canal has become obliterated. In describing these changes it is important for the beginner to accustom himself to describe the condition of the cervix accurately. For example, before obliteration of the cervical canal, he should express its length in centimeters, as well as the diameter of the external os; whereas, after the canal is obliterated, he should note that fact and state that the external os is so many centimeters in diameter and its margins so many millimeters thick, as it is only by so doing that it is possible to convey to someone else an accurate picture of the conditions.

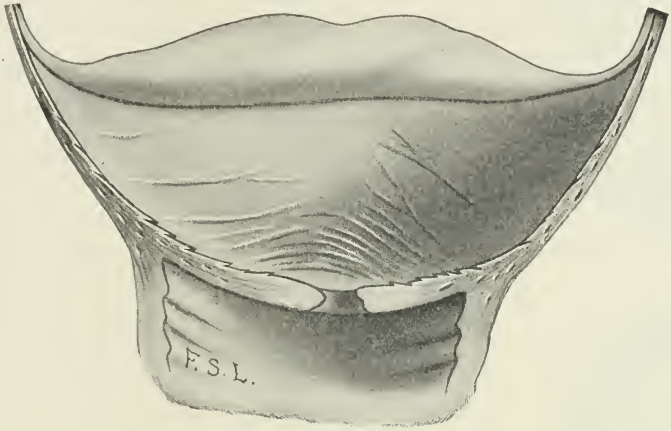


FIG. 244.—CERVICAL CANAL COMPLETELY OBLITERATED, EXTERNAL OS INTACT. × I.

Changes in the Uterus during the Second Stage of Labor.—By the end of the first stage of labor the uterine contractions have resulted in the differentiation of the organ into two parts, which are separated from one another by the contraction ring. Above is the active, contractile portion, which becomes thicker as labor advances, and below the thin-walled, passive, lower uterine segment and cervix (Fig. 241).

While these changes are being effected, there has been no descent on the part of the fœtus, and, as a rule, the position of the presenting part remains unchanged until after the cervix has become completely dilated. With the commencement of the second stage, however, descent begins, and under normal conditions continues slowly but steadily until delivery is accomplished. Naturally, the differentiation into stages is more or less arbitrary, so that it occasionally happens that the presenting part begins to descend during the latter part of the first stage.

After it has brought about complete dilatation of the cervix, the bag of waters has served its function, and rupture usually now occurs, which is manifested by a sudden rush of a variable quantity of a tolerably clear fluid from the vagina. On the other hand, the membranes may give way some time before complete dilatation of the cervix has been brought about; while occasionally they may retain their integrity until the completion of labor, so that the fœtus is born surrounded by them, the portion covering its head being designated as a *caul.*

Attention has already been directed to the changes in shape which the uterus presents during contraction. These may be noticed in the first, but more especially in the second stage, when the organ increases considerably in length, and at the same time diminishes in its transverse and antero-posterior diameter with each contraction. The increase in length is due partly to the stretching of the lower uterine segment, and partly to a straightening out of the fœtus. but we are unable to make definite statements as to the part played by each factor. With the formation of the lower uterine segment, the upper portion of the uterus increases greatly in thickness, and, as labor proceeds, covers a progressively decreasing portion of the child. Thus, when the head is upon the perineum, less than one-half of the fœtus is in the upper segment. In obstructed labors, in which definite disproportion exists between the size of the presenting part and the pelvic canal, the lower uterine segment is subjected to excessive stretching, and consequently the contraction ring assumes a much higher level, when it can be palpated as a distinct transverse or oblique ridge at a variable level between the symphysis pubis and umbilicus. In such circumstances, its recognition indicates that rupture of the uterus is imminent and will occur if the labor is not promptly ended.

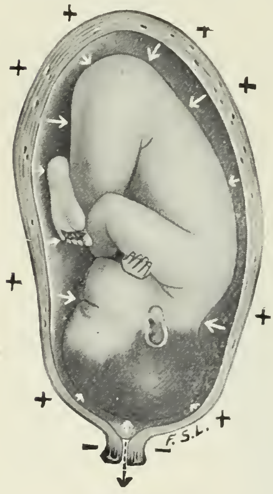


Fig. 245.—Diagram Showing Action of Intra-uterine Pressure, Membranes not Ruptured.

Forces Concerned in Labor.—As long as the membranes are unruptured during the first stage and the uterus contains a normal quantity of amniotic fluid, as well as in the rare instances in which they remain intact, during the second stage, whatever force is exerted by the contracting uterus is transmitted to the liquor amnii, and by it to the fœtus. In accordance with the laws of fluid pressure, therefore, it is applied with equal intensity to all portions of the child, and, were it not that the lower uterine segment and cervix represent the point of least resistance in the uterus, all its effect would be wasted; whereas, in the circumstances, it gives rise to stretching of the lower uterine segment and to dilatation of the cervix, but plays no part in causing the descent of the child. Attention was first directed to this point by Schatz and Lahs, and all subsequent authorities have accepted their conclusions.

After rupture of the membranes, a greater or lesser portion of the amniotic fluid escapes from the uterus, but in vertex presentations the presenting part usually acts as a fairly efficient tampon and causes the retention of a quantity sufficient to fill out the interstices between the fœtus and the uterine walls. Lahs believed the amount retained was usually sufficient to prevent actual contact with the surface of the fœtus, and therefore held that extrusion of the latter was brought about by fluid pressure alone. He argued that in such circumstances (Fig. 246) the entire surface of the fœtus, except the portion projecting through the cervix, would be subjected to fluid pressure, which, as it is equal in all directions, would exert no effect upon the fœtus, except in a line passing through the center of the portion not subjected to it, thus manifesting itself as a downward force bringing about descent.

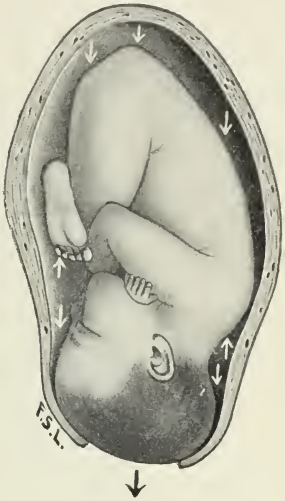


Fig. 246.—Diagram Showing Action of Intra-uterine Pressure after Rupture of the Membranes.

On the other hand, Lahs held that in all other presentations, as well as in vertex presentations after the amniotic fluid has almost completely drained off, other factors come into play which he regarded as distinctly pathological. In such cases the contracting uterus would come in direct contact with the surface of the fœtus, and the force exerted by the fundus would be directly transmitted to the presenting part by way of the vertebral column.

Most recent writers have not hesitated to accept Lahs' interpretation, but Olshausen, in 1901, directed attention to the fact that the latter force comes into play even in normal vertex presentations. He pointed out that only four frozen sections, through women dying in the second stage of labor, were available for the study of the question—namely, two of Braune and those of Chiari and of Barbour—and that in three of them the fundus was in direct contact with the breech of the child. Warnekros has made similar observations upon the living woman by means of the x-ray.

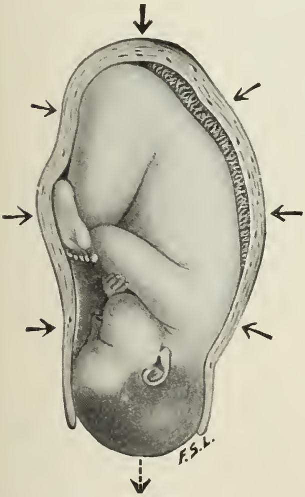


Fig. 247.—Diagram Showing Direct Pressure Exerted by Fundus after Complete Evacuation of Amniotic Fluid.

Furthermore, Olshausen estimated that at least 300 cubic centimeters of amniotic fluid were required to fill out the interstices between the surface of the fœtus and the uterine wall, and stated that fluid pressure could play no part in the expulsion of the fœtus unless a greater quantity were present. On the other hand, he found that the amount of amniotic fluid escaping when the child is born, which approximately represents the quantity remaining in the uterus during the second stage, did not exceed that quantity in 80 per cent of the patients whom he studied. Furthermore, in three-fifths of the women it was not over 200 cubic centimeters—an amount by no means sufficient to fill out the interstices, let alone to separate the breech from the fundus, which is essential for the proper action of fluid pressure. He therefore concluded that in such circumstances direct pressure must be exerted upon the breech, whence it is transmitted through the vertebral column to the head, and that this is rendered possible by a straightening out of the body of the child and its conversion into a comparatively rigid object, which is brought about by the diminution in the transverse and anteroposterior diameters of the uterus.

Consequently, the descent of the presenting part is partly due to the straightening out of the body of the child. According to Schroeder, its length from vertex to breech is thereby increased by 5.5 centimeters; while Olshausen considers that the increase is considerably greater, and may be as much as 13 centimeters. Part of this, it is true, is counterbalanced by the greater length of the uterus, but the remainder is an important factor in causing descent.

In addition to these factors, the contractions of the abdominal muscles of the woman also play no mean part in effecting the extrusion of the child; indeed, according to Schroeder, they alone bring it about. Olshausen, while not denying their importance, does not consider that they are the sole factor concerned. It is apparent, however, that their action is usually essential, for when it is absent, or only partially comes into play, labor is frequently so delayed that resort to forceps becomes necessary.

When the head has descended through the pelvis and is resting on the pelvic floor, more than half of the entire length of the child lies beneath the contraction ring; moreover, as the upper portion of the uterus becomes thicker and thicker, it necessarily exerts a diminished effect, so that, in the majority of cases, it becomes essential that the abdominal contractions should participate in the work.

Immediately after the birth of the child a striking change occurs in the position and size of the uterus, and on palpation it can be distinguished as a firm, rounded body which does not reach to the umbilicus. At this time its contracted and retracted body is freely movable above the collapsed lower uterine segment and cervix, and can readily be displaced in any desired direction.

Changes in the Vagina and Pelvic Floor during Labor.—The outlet of the pelvis is closed by a number of layers of tissue, which together constitute what is known as the pelvic floor. Beginning from within outward one meets successively with the peritoneum, the subperitoneal connective tissue, the internal pelvic fascia, the levator ani and coccygeus muscles, the external pelvic and perineal fascia, and, included between the latter, the superficial muscles of the perineum, external to which are the subcutaneous tissue and the cutaneous covering of the perineal and vulval regions.

Of these structures the most important are the levator ani muscle and the fascia covering its upper and lower surfaces, which for practical purposes may be considered as constituting the pelvic floor. This muscle closes the lower end of the pelvic cavity as a diaphragm, and presents a concave upper and a convex lower surface. On either side it consists of a pubic and iliac portion; the former is a band 2 to 2.5 centimeters in width, which arises from the horizontal ramus of the pubis 3 to 4 centimeters below its upper margin, and 1 to 1.5 centimeter from the symphysis pubis. Its fibers pass backward and encircle the rectum, and possibly give off a few fibers which pass behind the vagina. The greater or iliac portion of the muscle arises on either side from the white line—the tendinous arch of the pelvic fascia—and from the ischial spine, at a distance of about 5 centimeters below the margin of the superior strait. Its fibers do not possess a uniform arrangement, but, according to the researches of Dickinson, the following portions can be distinguished: Passing from before backward, there is a narrow band which crosses the pubic portion and descends to the rectovaginal septum. The greater part of the muscle passes backward and unites with that from the other side of the rectum, while the posterior portions meet together in a tendinous raphé in front of the coccyx, the most posterior fibers being at-

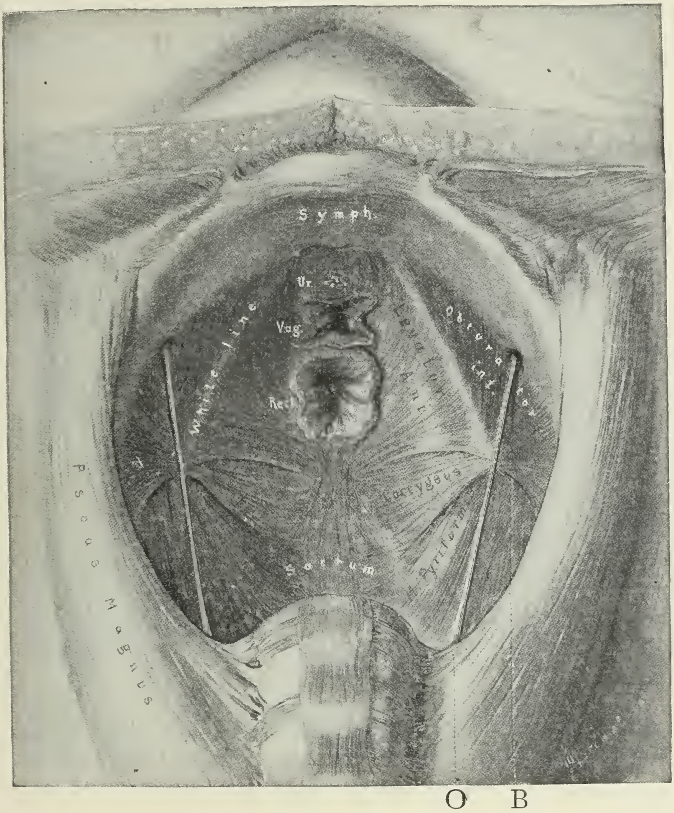


Fig. 248.—The Pelvic Floor Seen from Above (Kelly).
O, obturator nerve; *B*, border of great sciatic foramen.

tached to the bone itself. The posterior and lateral portions of the pelvic floor, which are not filled out by the levator ani muscle, are occupied by the pyriformis and coccygeus muscles on either side.

The levator ani muscle varies from 3 to 5 millimeters in thickness, though its margins, which encircle the rectum and vagina, are somewhat thicker. It undergoes considerable hypertrophy during pregnancy, and on vaginal examination its internal margin can be felt as a thick band extending backward from the pubis and encircling the vagina, about 2 centimeters above the hymen. On contraction it serves to draw both the rectum and vagina forward and upward in the direction of the symphysis pubis, and is to be regarded as the real closer of the vagina, since the constrictor cunni, one of the superficial muscles of the peritoneum, is too delicate in structure to have more than an accessory function.

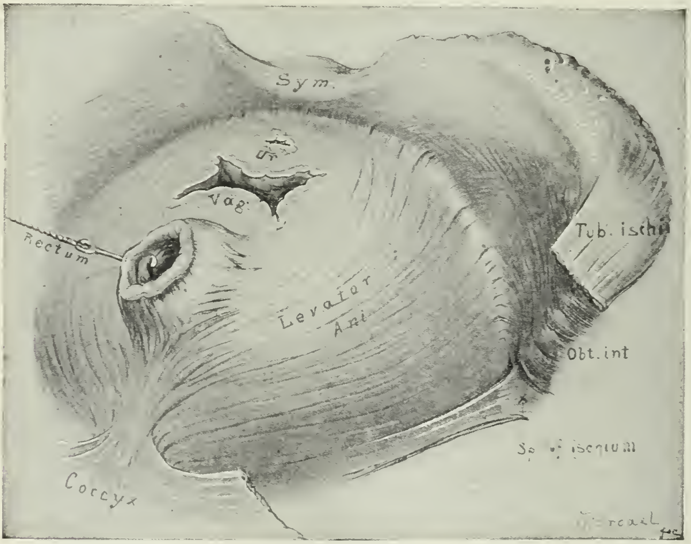


Fig. 249.—The Pelvic Floor Seen from Below (Kelly).

Although Farabeuf estimated that the levator ani upon contraction exerts a force of from 12 to 15 kilograms, it is generally believed that it is not sufficiently strong to afford support to the pelvic contents were it not reënforced by the strong pelvic fascia. Paramore, in 1910, expressed a contrary view, but the prevailing opinion was well summarized by Eduard Martin, in 1911. The internal pelvic fascia, which forms the upper covering of the levator ani, is attached to the margin of the superior strait, where it is joined by the fascia lining the iliac fossæ, as well as by the transverse fascia of the abdominal walls. It passes down over the pyriformis and the upper half of the obturator internus muscle and is firmly attached to the periosteum covering the lateral wall of the pelvis, the white line indicating its point of deflection from the latter, whence it spreads out over the upper surface of the levator ani and coccygeus muscles.

The inferior fascial covering of the pelvic diaphragm is divided into two parts at a line drawn between the ischial tuberosities. Its posterior portion consists of a single layer which, taking its origin from the sacrosciatic ligament and the ischial tuberosity, passes up over the inner surface of the ischial bones and the obturator internus muscles to the white line, in whose formation it takes part. From this tendinous structure it is reflected at an acute angle over upon the inferior surface of the levator ani, the space included between the latter and the lateral pelvic wall being designated as the ischiorectal fossa. The structure filling out the triangular space between the pubic arch and a line joining the ischial tuberosities is known as the urogenital diaphragm, which, exclusive of skin and subcutaneous fat, consists principally of three layers of fascia: (1) the deep perineal fascia which covers the anterior portion of the inferior surface of the levator ani muscle and is continuous with the fascia just described; (2) the middle perineal fascia which is separated from the former by a narrow space in which are situated the pudic vessels and nerves; (3) the superficial perineal fascia, which, together with the layer just described, form a compartment in which lie the superficial perineal muscles, with the exception of the sphincter ani, the rami of the clitoris, the vestibular bulbs, and the vulvovaginal glands.

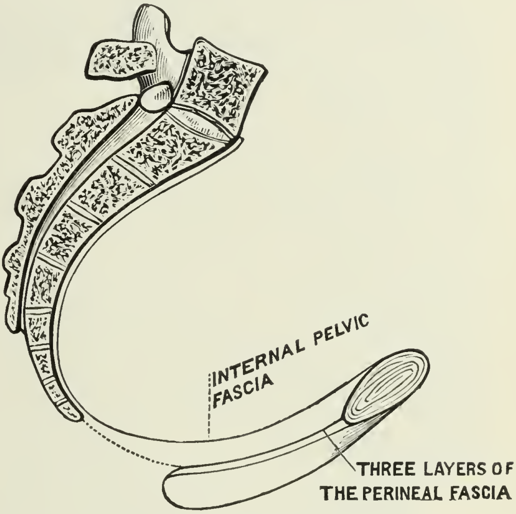


Fig. 250.—Diagram Showing Arrangement of Pelvic and Perineal Fascia (Tarnier).

The superficial perineal muscles consist of the constrictor cunni, the ischiocavernosus, and the transversus perinei muscles. These structures are delicately formed and possess no obstetrical significance, except the last-named muscles, which are always torn through in perineal lacerations, when they serve in great part to bring about gaping of the wound. Studdiford holds that the perineal body, anterior and interior to the sphincter ani, contains numerous strands of nonstriated muscle, which also play an important part in perineal tears.

In the first stage of labor the bag of waters takes part in the dilatation and distention of the upper portion of the vagina, which has been prepared for the process by important changes in its mucosa and connective tissue, while Stieve has shown that its unstriped muscular fibers undergo almost as great hypertrophy as those of the uterus itself. Furthermore, Runge contends that radical chemical changes occur in the colloids of the vaginal wall, by which they become

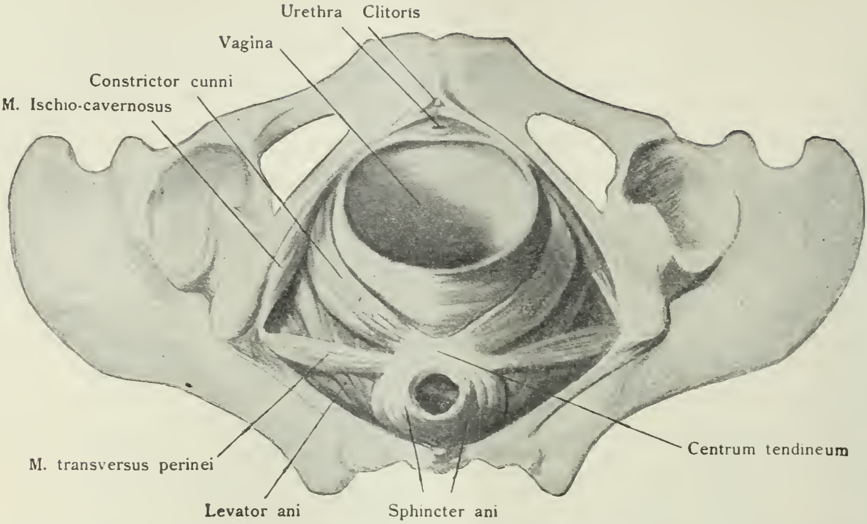

Urethra
Clitoris
Vagina
Constrictor cunni
M. Ischio-cavernosus
Centrum tendineum
M. transversus perinei
Levator ani
Sphincter ani

Fig. 251.—Pelvic Floor Distended by Presenting Part, Showing Superficial Muscles of Perineum (Bumm).

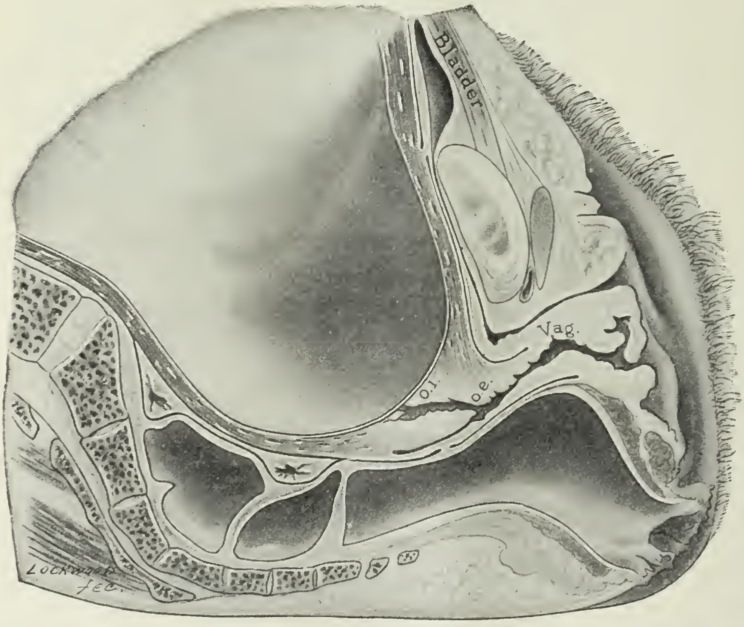

Bladder
Vag.
o.i.
o.e.
Lockwood fec.

Fig. 252.—Frozen Section Showing Condition of Birth Canal in Last Month of Pregnancy (Braune and Zweifel). × ½.

more hydrophilic, and thus better able to undergo the necessary plastic changes. But after the membranes have ruptured the changes occurring in the pelvic floor are due entirely to the pressure exerted by the presenting part. As this descends, the anterior portion of the pelvic floor becomes forced against the inferior and posterior portions of the symphysis. On the other hand, the posterior portion undergoes marked changes, becoming pushed downward and forward, and subjected to great stretching, eventually being converted into a thin-walled, tubular structure—the perineal gutter. Figure 251 gives a good idea of the changes occurring in the pelvic floor, and demonstrates the important part played by the levator ani and the altogether insignificant function of the superficial perineal muscles. When the head distends the vulva, its opening looks upward and forward, and the course of the birth canal along the pelvic floor follows the curve indicated in Figures 238 and 253.

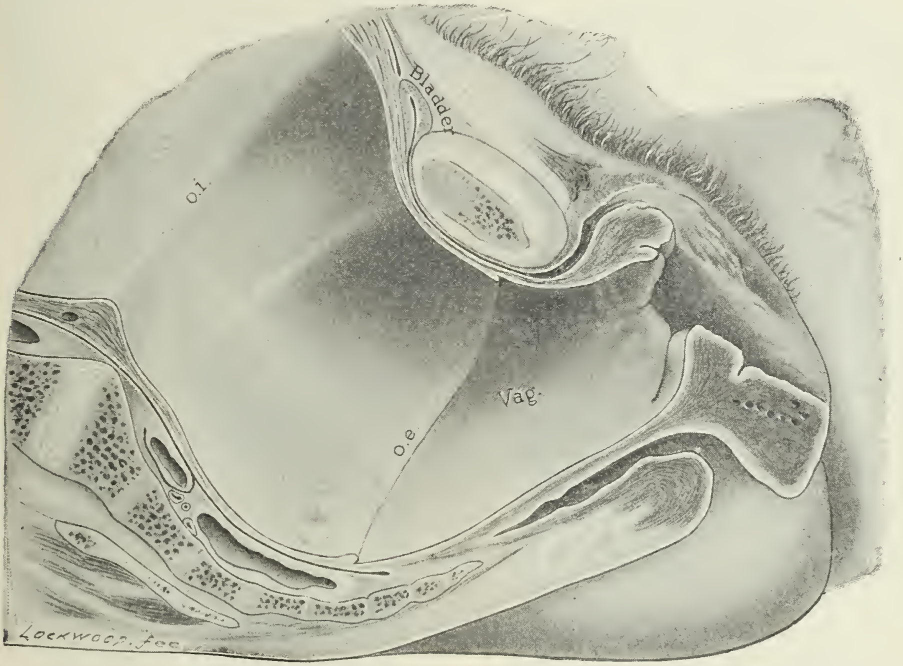


Fig. 253.—Frozen Section Showing Condition of the Birth Canal in First Part of Second Stage of Labor (Braune). × ½.

Webster has pointed out that the most marked change consists in the stretching of the fibers of the levator ani muscle and the thinning of the central portion of the perineum, which becomes transformed from a wedge-shaped mass of tissue 5 centimeters in thickness to a thin, almost transparent membranous structure 2 to 4 millimeters thick. At the same time it is pushed down about 2.5 centimeters from its original position.

When the perineum is distended to the utmost, the anus becomes markedly dilated, and presents an opening which varies from 2 to 2.5 centimeters in diameter, through which the anterior wall of the rectum is seen to bulge. Küstner has called attention to the fact that important preparatory changes make it possible for the pelvic floor to withstand such distortion without too much damage—and has adduced histological evidence to prove that the muscles, connective tissue and skin all undergo very considerable hypertrophy.

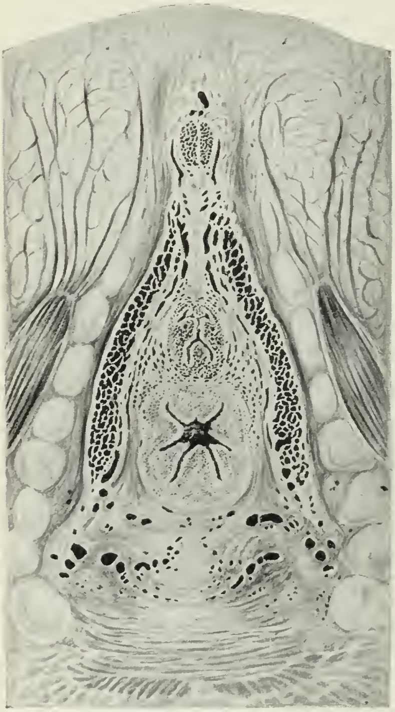


Fig. 254.—Cross Section of the Outlet of a 27-Year-Old Bipara, Eight Months after Delivery.

The contents of the blood vessels are shown in black (Stieve).

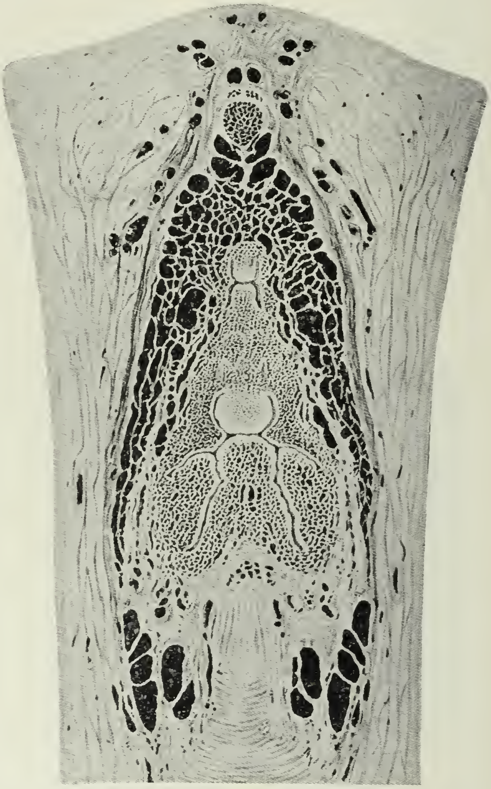


Fig. 255.—Cross Section of Outlet of 26-Year-Old Quadripara who Died Two Days after Delivery.

The extreme vascularity of parts is shown (Stieve).

Stieve has likewise emphasized the extraordinary increase in the number and size of the vessels supplying the vagina and pelvic floor, so that by the end of pregnancy practically the entire area between the anterior half of the vagina and the pubic arch has become converted into an erectile tissue, as shown in Figures 254 and 255. It is apparent that such an arrangement makes great compression possible, but at the same time it greatly increases the danger of hemorrhage if the tissues are torn through.

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CHAPTER XII

MECHANISM OF LABOR IN VERTEX PRESENTATIONS

Vertex presentations occur in from 95 to 97 per cent of all cases—94.6 per cent in 7000 consecutive cases in my service—and in them, as was first pointed out by Naegele, the sagittal suture nearly always engages in the right oblique diameter of the pelvis. In other words, one usually has to deal with a left occipito-anterior or a right occipitoposterior presentation. That this is so, and that the first-mentioned presentation is the one most frequently observed, all the authorities are agreed; but that wide differences of opinion exist as to the relative frequency of the several other varieties is clearly shown by the following table:

	Dubois in Per Cent of 1913 Cases	Pinard in Per Cent of 500 Cases	Author in Per Cent of 6877 Cases
L. O. A.	71.00	52.6	54.08
L. O. P.	0.63	11.0	9.14
R. O. A.	2.87	0.2	25.09
R. O. P.	25.6	38.8	11.68

E. D. Plass, upon analyzing the incidence of the several varieties in 5445 vertex presentations in my service, gives the following figures:

L. O. A., 47.8; L. O. T., 12.9; and L. O. P., 3.3 per cent.

R. O. A., 19.1; R. O. T., 8.9; and R. O. P., 8.0 per cent.

As many of our patients were not examined until late in labor, our figures do not adequately represent the initial incidence, as it is probable that a considerable proportion of the cases which are recorded as L. O. T. or R. O. T. originally entered the pelvis with the occiput obliquely posterior. That this inference is justified is shown by the fact that in 500 cases from my private practice the obliquely posterior varieties were noted more than twice as frequently as in his series. Statistics of German authorities are not available for comparison, as they usually only indicate whether the occiput is directed toward the left or right side of the mother, and do not distinguish between the several varieties. Thus, Zweifel, in 9351 vertex presentations, found the occiput directed to the left in 71.1 and to the right in 28.9 per cent, as compared with 64 and 36 per cent, respectively, in our series.

Mechanism in Left and Right Occipito-anterior Presentations.—We shall consider in the first place the mechanism of labor in the anterior varieties of vertex presentation—namely, the left and right occipito-anterior.

Diagnosis.—The mode of presentation of the fœtus is most reliably determined by abdominal palpation, which can be utilized not only during pregnancy

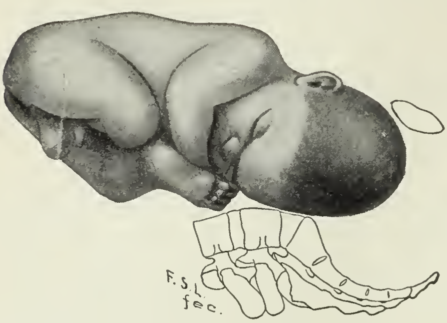


Fig. 256.—Diagram Showing Child in L. O. A.

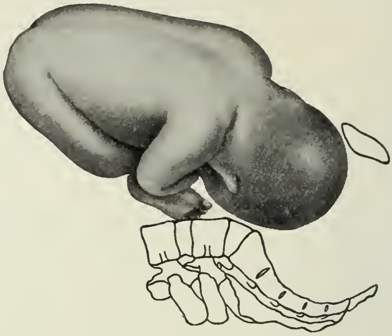


Fig. 257.—Diagram Showing Child in R. O. A.

but also at the time of labor, provided it be practiced in the intervals between the pains. Its accuracy, however, is greatly impaired in patients with very fat abdominal walls, or in whom the uterus is unduly distended by an excessive amount of amniotic fluid, or deformed by subperitoneal or intramural myomata, as the latter may occasionally be mistaken for portions of the child.

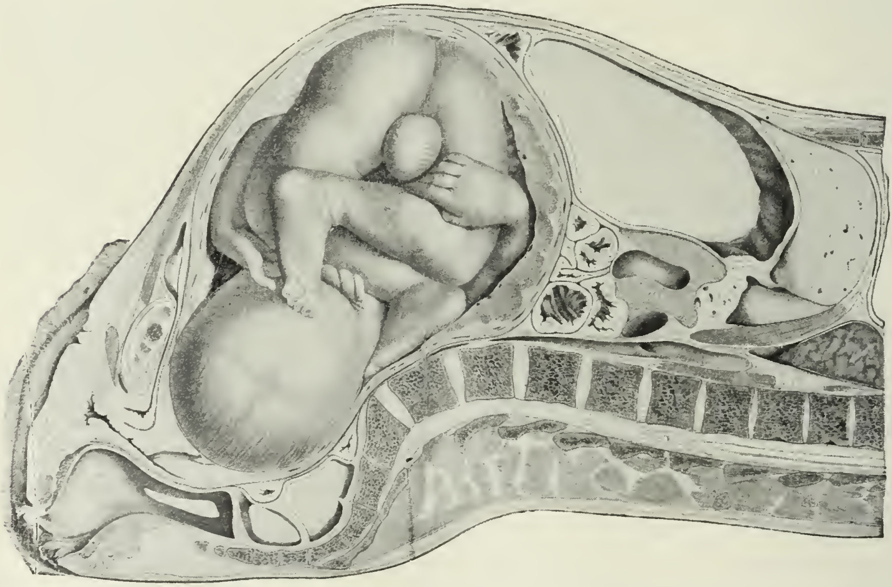


Fig. 258.—Frozen Section through Woman at End of Pregnancy, Child in R. O. T. (Zweifel).

For purposes of diagnosis we employ the four maneuvers already described, and with the fœtus in the left occipito-anterior position obtain the following:

First maneuver: Irregular breech at fundus.
Second maneuver: Resistant plane of back on the left and anterior portion of the abdomen, with the small parts on the right side.
Third maneuver: If the head be not engaged, it is felt as a freely movable body over the superior strait; but if it be fixed, the anterior shoulder may be detected.
Fourth maneuver: Negative if the head be not engaged; otherwise the cephalic prominence is felt on the right side (Plate X).

For the right occipito-anterior position the findings are as follows:

First maneuver: Irregular breech at fundus.
Second maneuver: Resistant plane of back on the right and anterior portion of the abdomen, with the small parts on the left side.
Third maneuver: As in L. O. A.
Fourth maneuver: Cephalic prominence on the left side (Plate XI).

Until the head has become engaged the information obtained by vaginal or rectal examination is relatively meager; and even after engagement satisfactory results cannot usually be obtained until the cervix has become sufficiently dilated to permit the differentiation of the various sutures and fontanels. When this is possible and the child lies in the left anterior variety the sagittal suture will be found to occupy the right oblique diameter of the pelvis, with the small fontanel in the neighborhood of the left iliopectineal eminence and the large fontanel directed toward the right sacro-iliac synchondrosis. In the right anterior variety the sagittal suture occupies the left oblique diameter, the small fontanel lying in the neighborhood of the right iliopectineal eminence, while the large fontanel looks toward the left sacro-iliac synchondrosis.

The diagnostic value of vaginal examination may be still further impaired when the presence of a marked *caput succedaneum* makes it impossible to feel the sutures and fontanels.

In the left anterior positions the fœtal heart sounds are usually heard on the left side of the abdomen along a line joining the umbilicus and the left anterior-superior spine of the ilium; and in right positions at a corresponding point on the right side.

Mechanism.—Owing to the irregular shape of the pelvic canal and the relatively large dimensions of the mature fœtal head, it is apparent that any portion of the latter, chosen at random, cannot necessarily pass through every plane of the former; hence, it follows that some process of adaptation or accommodation of suitable portions of the head to the various pelvic planes is necessary to insure the completion of childbirth. This is brought about by certain movements of the presenting part, which constitute what is termed the mechanism of labor.

For purposes of instruction, one is obliged to describe the various movements as if they occurred separately and independently of one another; whereas, in reality, the mechanism of labor consists of a combination of movements, several of which may be going on at the same time, as it is manifestly impossible for any one of them to occur unless the presenting part descends simultaneously.

These movements are divided into two classes, according as they are essential to the completion of labor, or as they merely facilitate its progress. To the first group belong the so-called cardinal movements—*descent, internal rotation,* and *extension;* to the second the accessory movements—*flexion* and *external rotation.* As a preliminary to these movements, the uterine contractions bring about important modifications in the attitude or habitus of the fœtus, which according to Sellheim, greatly facilitate the act of labor. These consist principally in a straightening out of the fœtus, so that its back loses its convexity, while the extremities and small parts are more closely applied against the body, with the result that the fœtal ovoid becomes transformed into a cylindrical body with the smallest possible cross section.

Engagement.—The mechanism by which the presenting part enters the superior strait is designated as engagement. This is best studied in women who have borne one or more children, for the reason that some weeks before the onset of labor in primiparæ the head normally descends so deeply into the pelvic canal that its most dependent portion lies just above a line joining the ischial spines; whereas in multiparous women this usually does not occur until after the commencement of labor.

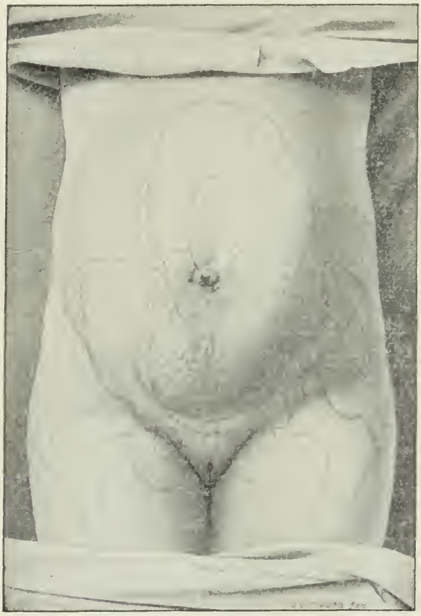


Fig. 259.—Position of Fœtus before Engagement.

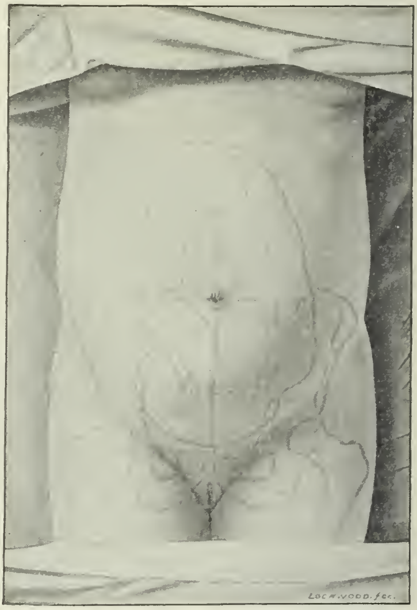
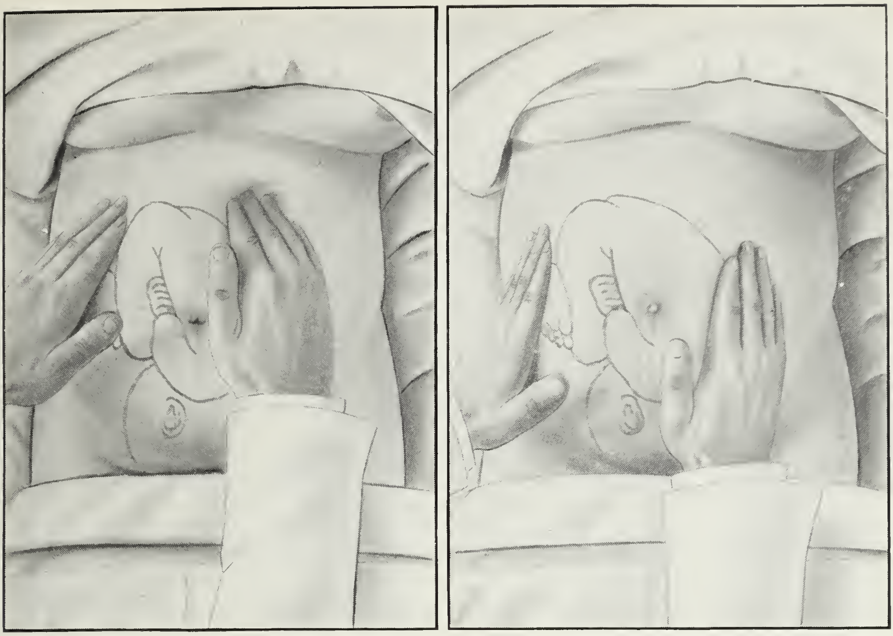


Fig. 260.—Position of Fœtus after Engagement.

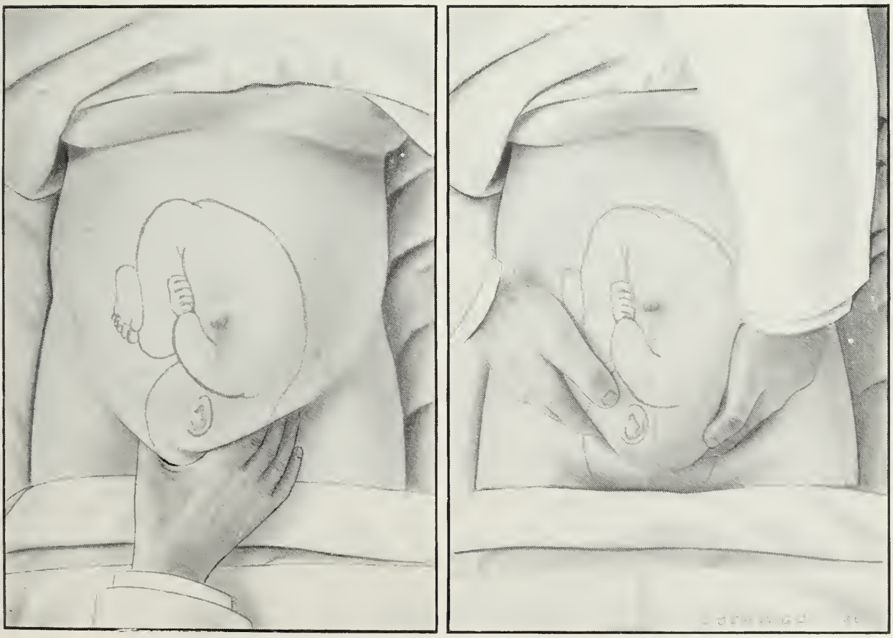
In most multiparæ at the end of pregnancy the head, which occupies a position midway between flexion and extension, is freely movable above the superior strait, or rests upon one or other iliac fossa. Accordingly, when the uterine contractions set in and force it toward the pelvic opening, the cephalic circumference

PLATE X.



First Maneuver.

Second Maneuver.



Third Maneuver.

Fourth Maneuver.

PALPATION IN LEFT OCCIPITO-ANTERIOR PRESENTATION.

which first engages is the one that passes through the extremities of the fronto-occipital diameter. This normally measures 11.5 centimeters; and, as the conjugata vera is only 11 centimeters in length in the bony pelvis, and is encroached upon by various tissues in the living woman, it is apparent that a normal-sized head cannot engage with its sagittal suture directed anteroposteriorly. Accordingly, it must enter the superior strait either in the transverse or in one of its oblique diameters (12.75 centimeters). As has already been said, this usually occurs in the right oblique diameter, so that one end of the sagittal suture is directed toward the left iliopectineal eminence, and the other toward the right sacro-iliac synchondrosis. This is attributable to two factors. In the first place, the fœtus, in the later months of pregnancy, tends to assume this position spontaneously; and secondly, the posterior end of the left oblique diameter is encroached upon by the rectum; so that, for practical purposes, it is shorter than the right.

At first glance it may appear strange that the head does not engage in the transverse diameter of the pelvis, which measures 13.5 centimeters; but when one recalls the normal outlines of the superior strait (Figs. 261 and 262), it is seen that this diameter extends only a few centimeters in front of the promontory of the sacrum, so that for practical purposes the available transverse diameter is one which bisects the conjugata vera, and is more than a centimeter shorter than the oblique diameter.

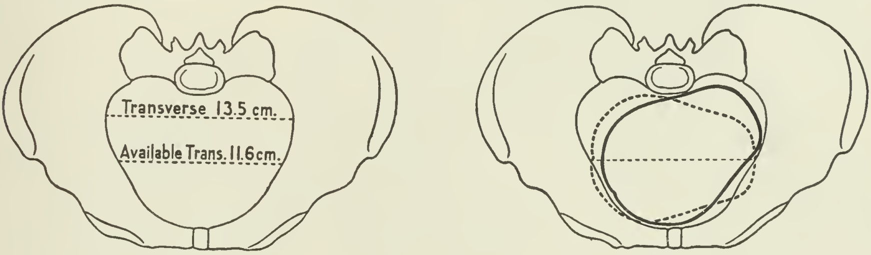


Fig. 261. Fig. 262.

Figs. 261, 262.—Diagrams Showing Why the Head Does not Engage in the Transverse Diameter of the Superior Strait.

Prior to the middle of the eighteenth century little was known concerning the mechanism of labor, and it was generally thought that the head entered the pelvis with the sagittal suture directed anteroposteriorly. Fielding Ould, in 1742, was the first to protest against such a view, and within the following thirty years the observations of Smellie, Saxtorph, and Solayrès de Renhac demonstrated that engagement occurs in the manner just described. It is true that Sentex, McKerron, Müller, and Martius have revived the older teachings, and report that once in several hundred labors the head engages with the small fontanel either just behind the symphysis pubis or just in front of the promontory of the sacrum—occipitopubic or occipitosacral presentation. While most authorities teach that in such circumstances labor is extremely difficult, Martius contends that a spontaneous outcome is possible in three out of four cases. However this may be, engagement in such a manner occurs so rarely as to be a curiosity, and should be regarded as abnormal.

Naegele, in 1838, held that engagement took place in such a way that the sagittal suture assumed an eccentric position, being nearer the promontory of the sacrum than the symphysis, and that therefore the anterior parietal bone of the fœtus was first felt on vaginal examination—*Naegele's obliquity.* Varnier, and Le Lorier, on the other hand, contend that the reverse is the case, and that the head enters the pelvis with its sagittal suture nearer the symphysis pubis, so that the posterior parietal bone is first felt on examination.

Neither of these views is quite correct when the pelvis is normal and the uterus not pendulous. The first presupposes that the axis of the uterus is to be found somewhat in front of that of the superior strait, and the second that it lies posterior to it. It would seem that Varnier overlooked the fact that the cadavers upon which his conclusions were based were frozen in the horizontal position, when the flaccid uterus would rest upon the vertebral column. In the living woman, however, such conditions do not obtain, as the uterus rises with each contraction, so that its long axis tends to correspond with that of the superior strait. Moreover, careful vaginal examination reveals the fact that the head usually engages in such a manner that its sagittal suture lies either in the middle of the pelvis or approaches the promontory of the sacrum but slightly, but not by any means to the extent that Naegele had supposed. On the other hand, the condition of affairs noted by Varnier obtains only when considerable disproportion exists between the size of the head and the pelvis, and should be regarded as distinctly pathological.

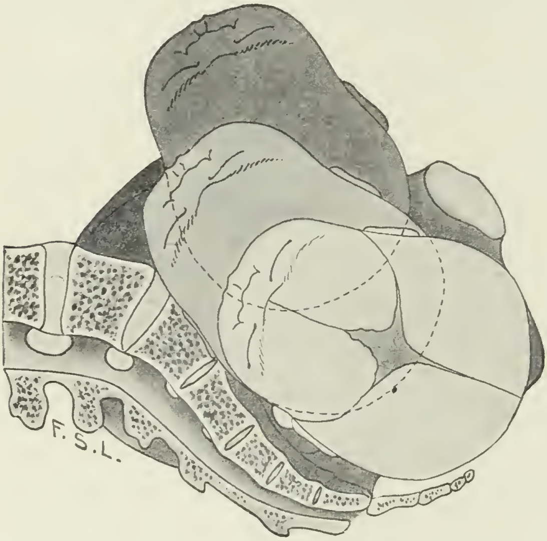


Fig. 263.—Diagram Illustrating Synclitism (Ahlfeld).

Descent.—The first requisite for the birth of the child is descent, whose extent varies materially according as the patient is a primipara or a multipara. In the former, when there is no disproportion between the size of the head and the pelvis, engagement is already so deep at the onset of labor that the most dependent part of the head is at, or only slightly above, the level of the ischial spines, so that farther descent does not begin until the second stage of labor sets in. In multiparæ, on the other hand, descent begins with engagement. It should, however, be remembered that in either event, once having been inaugurated, descent is inevitably associated with the various movements to which reference will be made. Descent is brought about by one or more of four forces: (1) intra-uterine fluid pressure; (2) direct pressure of the fundus upon the breech; (3) contraction of the abdominal muscles, and (4) extension and straightening of the child's body.

The x-ray studies of Warnekros show that during the first stage of labor the back of the child is markedly convex, but becomes straightened out during the second stage. This he considers affords conclusive evidence that the expulsive force exerted by the uterus is transmitted through the vertebral column of the child; while Sellheim contends that this is not the case, and that only fluid pressure is involved, as he holds that even after rupture of the membranes sufficient fluid is retained within the uterus to make it possible.

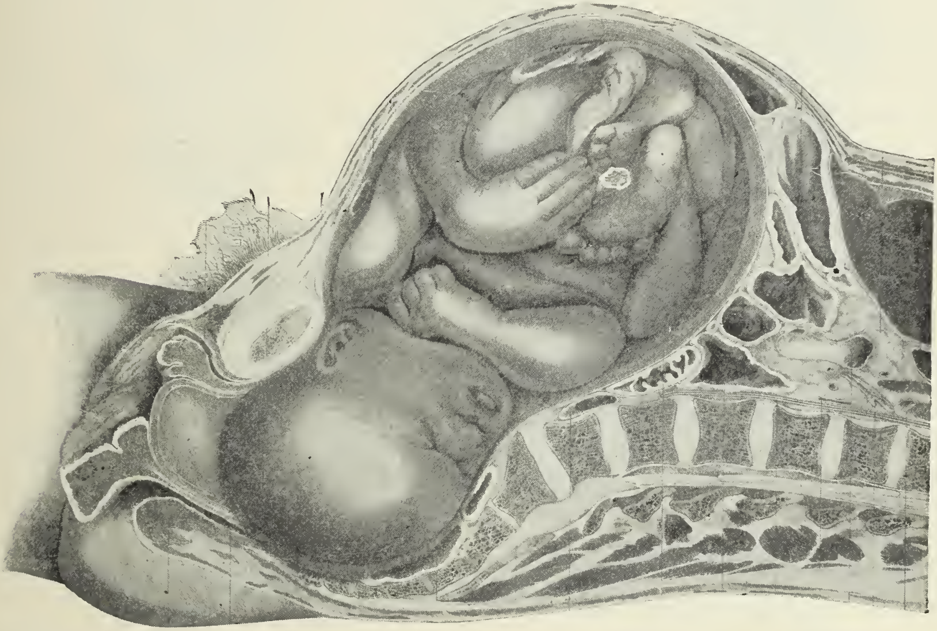


Fig. 264.—Frozen Section, Second Stage of Labor, Child in R. O. A., Membranes Unruptured (Braune). Compare with Fig. 258.

As the anterior surface of the sacrum and the posterior surface of the symphysis measure 12 and 5 centimeters, respectively, it is apparent that, if all parts of a body passing through the pelvic cavity are to reach the inferior strait at the same time, the one lying posteriorly must descend more rapidly than the anterior portion. This compensatory difference in the rate of descent of the portions of the presenting part occupying the anterior and posterior segments of the pelvis is known as *synclitism,* and is clearly illustrated in Fig. 263.

Flexion.—As soon as the descending head meets with resistance, whether it be from the margins of the superior strait or the cervix, the walls of the pelvis or the pelvic floor, flexion results. In this movement the head rotates about its transverse axis in such a manner as to bring the chin into more intimate contact with the thorax, thereby substituting the suboccipitobregmatic for the fronto-occipital diameter.

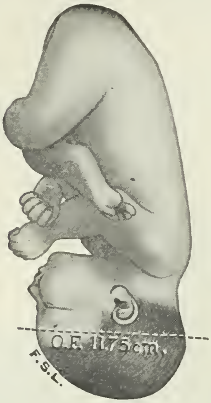


Fig. 265.

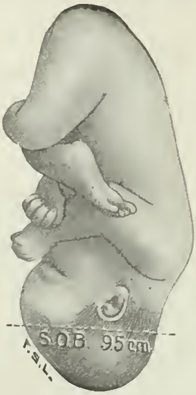


Fig. 266.

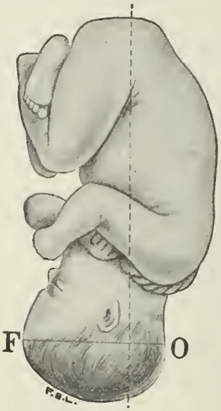


Fig. 267.

Figs. 265, 266.—Diagrams Showing Effect of Flexion; Conversion of Occipitofrontal into Suboccipitobregmatic Diameter.

Fig. 267.—Diagram Showing Head Lever (American Textbook).

This purely mechanical phenomenon, by which a diameter of 9.5 replaces one of 11.75 centimeters, is due to the manner in which the head is articulated with the vertebral column, whereby the former represents a two-armed lever, the short arm extending from the occipital condyles to the occipital protuberance, and the long arm from the same point to the chin (Fig. 267). It is therefore apparent that when resistance is encountered the long arm of the lever, following

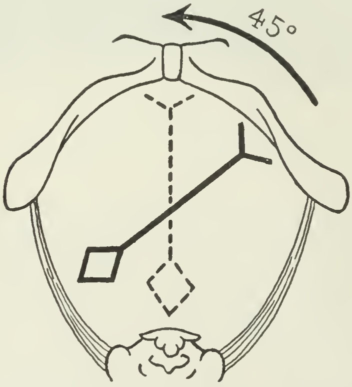


Fig. 268.—Diagram Showing Anterior Rotation from L. O. A.

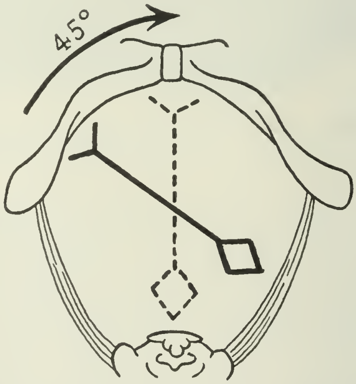


Fig. 269.—Diagram Showing Anterior Rotation from R. O. A.

the ordinary laws of mechanics, must ascend, while the short arm descends, and thus flexion is brought about.

The point of the birth canal at which this movement occurs varies greatly. When there is no disproportion between the presenting part and the pelvic canal pronounced flexion does not occur until the resistance of the pelvic floor is encountered, but if descent begins before the external os is fully dilated, especially if its margins are resistant, flexion may be completed before the head has left the uterus; while in generally contracted pelves the movement occurs in an exaggerated manner while engagement is being effected.

Internal Rotation.—By this is understood a turning of the head about its vertical axis in such a manner that the occiput gradually moves from the position which it originally occupied toward the symphysis pubis or the hollow of the sacrum, as the case may be.

Internal rotation is absolutely essential for the completion of labor, except when the child is abnormally small, and in the anterior varieties always occurs from left to right in left positions, and in the reverse direction in right positions (Figs. 268 and 269). Indeed, no matter what the original position of the head may be, the occiput usually rotates to the front, although exceptionally, in occipitoposterior presentations, it may turn toward the hollow of the sacrum. It should be remembered that internal rotation does not occur by itself, but is always associated with the descent of the presenting part, and is usually not effected until the head has become definitely flexed.

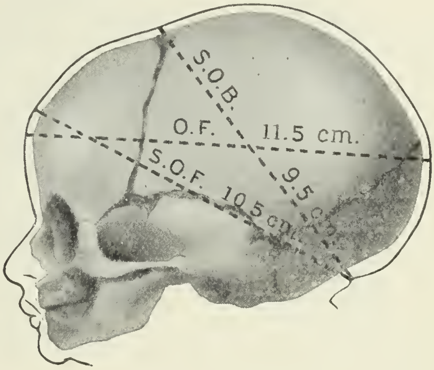


Fig. 270.—Diagram Showing Suboccipitobregmatic, Suboccipitofrontal, and Occipitofrontal Diameters.

Various theories have been advanced in the attempt to explain the manner in which internal rotation is brought about, and a vast literature has accumulated upon the subject, which was well reviewed by Paramore, in 1909. Prior to the time of Ould and Smellie nothing was known concerning this movement, but afterwards it was believed that it was rendered necessary by the shape of the pelvic canal, it having been taught that the superior strait represented an ellipse whose long axis lay transversely, and the inferior strait one whose long axis was anteroposterior; so that for the head to be born it was necessary that its sagittal suture be directed transversely or obliquely to pass through the former, and anteroposteriorly to pass through the latter. A little consideration, however, will show that this is not the case, for, when the coccyx is displaced backward during labor, the inferior strait presents an almost circular opening, its transverse and anteroposterior diameters being 11 and 11.5 centimeters, respectively. Varnier was therefore justified in concluding that the shape of the pelvis alone does not explain the production of this movement. Moreover, when we recall the fact that it is the suboccipitofrontal circumference of the head which passes through the pelvic outlet, and that its greatest diameter measures only 10.5 centimeters (Fig. 270), it is evident that unless some other factor were concerned internal rotation would not be necessary.

This factor is to be found in the structures of the pelvic floor, and in the oval shape of the vaginal outlet, but particularly in the levator ani muscle, which, yielding before the impact of the head, nevertheless exerts sufficient force upon it to compel it to adjust itself to its curvatures. Furthermore, the walls of the perineal gutter offer a concave inclined plane over which the rounded head readily glides in its downward course.

This explanation, although fairly satisfactory when the occiput is originally directed obliquely anteriorly in the pelvis, would not necessarily seem to apply with equal force to those cases in which it occupies an obliquely posterior position. But the following account of Dubois's experiment clearly demonstrates that even in such circumstances the pelvic floor exerts a predominating influence in the production of this movement: "In a woman who had died a short time previously in childbirth the uterus, which had remained flaccid and of large size, was opened up as far as the cervical orifice and held by assistants in a suitable position above the superior strait. The fœtus of the woman was then placed in the soft and dilated uterus in the right occipitoposterior position. Several pupil-midwives, pushing the fœtus from above, readily caused it to enter the cavity of the pelvis. Much greater force was needed to make the head travel over the perineum and clear the vulva, and it was not without astonishment that we saw, in three successive attempts, that, when the head had traversed the external genital organs, the occiput had turned to the right anterior position, while the face was turned to the left and to the rear. In a word, rotation had taken place as in natural labor. We repeated the experiment a fourth time, but as

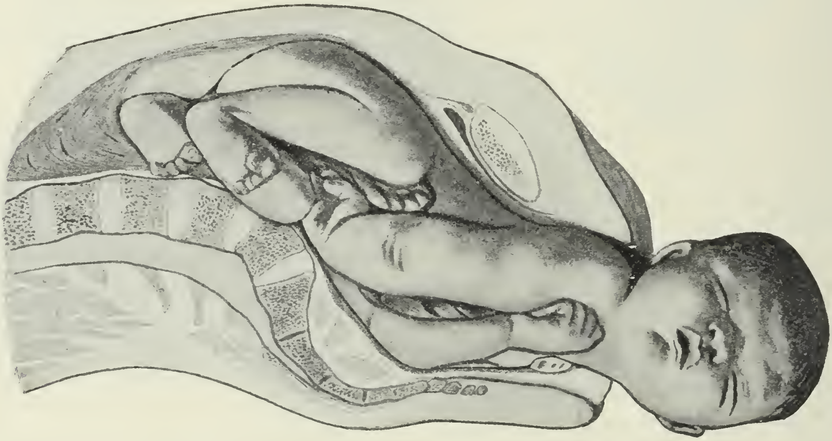


Fig. 271.—Frozen Section through Woman in Labor with Child Partly Delivered Showing Complete External Rotation of the Head and Imperfect Rotation of the Shoulders (Zweifel).

the head cleared the vulva the occiput remained posterior. We then took a dead-born fœtus of the previous night, but of much larger size than the preceding, and placed it in the same position as the first, and twice in succession witnessed the head clear the vulva after having executed the movement of rotation. Upon the third and following essays delivery was accomplished without the occurrence of rotation. Thus the movement only ceased after the perineum and vulva had lost the resistance which had made it necessary, or at least had been the inciting cause of its accomplishment."

From Solayrès de Renhac (1771) to the present time, many authors, among whom may be mentioned Scanzoni, Hodge, and Reynolds, have sought to explain the production of rotation by calling attention to the shape of the pelvic canal, and pointing out that the inclination of its walls—the *inclined planes of the pelvis*—serves to direct the occiput anteriorly. By others it was thought that the projecting ischial spines also played a similar part by interposing an obstacle to posterior rotation.

Schroeder, Olshausen, and Bumm believed that the movement was inaugurated by the body of the child rotating in such a way as to bring its back more to the front, and that the head followed it. They considered that this was brought about by an attempt on the part of the uterus to assume its normal flattened shape, as its contents were expelled. They did not contend that the shoulders were rotated into a directly transverse position, but considered that they remained somewhat behind the occiput, and that the partial rotation of the body merely inaugurated that of the head, which was completed by the action of other accessory factors.

Warnekros, on the contrary, states that while his x-ray plates show that rotation of the body frequently precedes that of the head, he is, nevertheless, inclined to believe that the pelvic floor plays the predominant part in bringing about the rotation of the latter. Even if such views are accepted as partially correct, it must be admitted that they fail to solve the entire problem; as a flattening of the uterine cavity cannot be invoked in explanation of the rotation of the shoulders into the anteroposterior diameter following the expulsion of the head. This must be regarded as a movement of internal rotation, just as well as that which the head had previously undergone, and must be brought about by identical causes; as it would seem improbable that one factor would be concerned in the causation of one rotation, and in a few minutes a second factor would bring about the other. Furthermore, the frozen section of Zweifel through a woman, who had died just after the birth of the child's head, shows that the shoulders had not yet rotated anteroposteriorly, and indicates that such a movement would be hampered, rather than facilitated, by a flattening of the uterus. (Fig. 27.)

Since 1906, Sellheim made several important contributions to the subject. He holds that internal rotation, and indeed the entire mechanism of labor, is the inevitable consequence of definite physical laws, one of the most important of which is that whenever a cylindrical body of suitable size, which can be bent to a different extent in several locations, is forced through a curved cylindrical canal, it must necessarily rotate until the portion which is most readily bent adapts itself to the curvature of the canal. By studying newly born children, he demonstrated that in vertex presentations such bending occurs most readily in the cervical region, and thus tends to bring about extension; while in face presentations it occurs in the opposite direction and brings about flexion. Accordingly, in the former rotation must take place until the posterior portion of the neck adapts itself to the "knee" of the birth canal, while in the latter the anterior portion of the neck must become so adapted, thus causing the occiput or chin to rotate anteriorly, as the case may be.

By a series of ingenious experiments Sellheim has shown that rotation always occurs in accordance with this law, and that it makes no difference whether the presenting part enters the pelvic canal in an obliquely anterior or posterior position. Unfortunately, his explanation has only carried us one step farther forward, and still leaves us in ignorance of the ultimate cause of the movement.

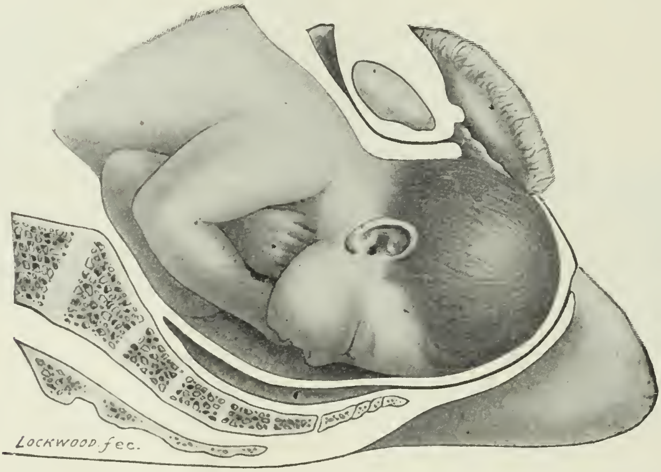


FIG. 272.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

Extension.—When, after internal rotation, the sharply flexed head reaches the vulva, it undergoes another movement which is absolutely essential to its birth—namely, it becomes so extended that the base of the occiput comes in direct contact with the inferior margin of the symphysis pubis. This movement is brought about by two factors. In the first place, as the vulval outlet looks upward and forward, extension must occur before the head can pass through it. For if the sharply flexed head, on reaching the pelvic floor, continued to be driven downward in the same direction as heretofore—in the axis of the superior strait—it would impinge upon the end of the sacrum and the posterior portion of the perineum, and, if the *vis a tergo* were sufficiently strong, would eventually carry away the lowermost portion of the former, and be forced through the tissues of the latter. But when the head presses upon the pelvic gutter, two forces come into play, the first acting downward, exerted by the uterus, and the second upward, supplied by the resistant pelvic floor, the resultant force being one directed forward and somewhat upward in the direction of the vulval opening, thereby giving rise to extension. Joseph Jones, in 1906, directed attention to the fact that the movement of extension does not occur merely at the articulation between the occiput and atlas, but is preceded and inaugurated by an extension of the entire cervical region. He holds that such a movement brings about a marked change in the manner in which the force exerted by the uterus is transmitted to the occiput, and likens it to the interposition of the crank shaft between the end of the piston and the wheel of an engine.

After the suboccipital region has come in contact with the inferior margin of the symphysis pubis, the head is no longer to be regarded as a two-armed, but simply as a one-armed lever, the occiput being the fulcrum with the arm extending from it to the chin, so that any force exerted upon the head must necessarily lead to further extension. As this becomes marked, the vulval opening gradually dilates and the scalp of the child becomes apparent through it. Now, if we mark the point which first appears, and carefully examine the child after its birth, we find in left occipito-anterior presentations that it was the upper and posterior margin of the right parietal bone that first came into view, while the reverse holds good in right occipito-anterior positions.

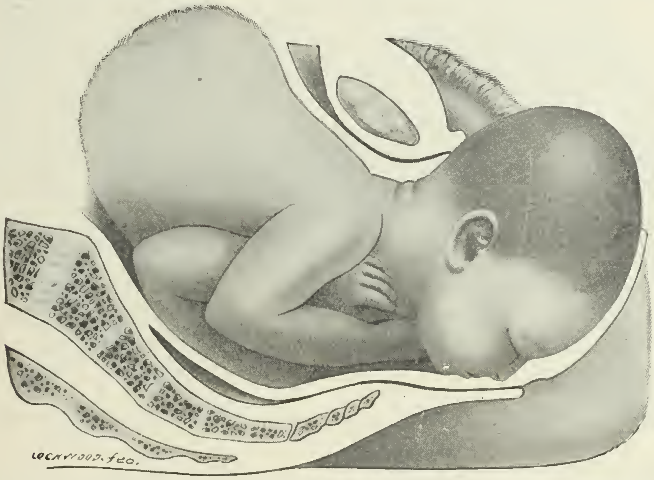


Fig. 273.—Diagram Showing Delivery of Head in Vertex Presentation.

With increasing distention of the perineum and vaginal opening, a larger and larger portion of the occiput gradually appears, and the head is born by further extension, the occiput, bregma, forehead, nose, mouth, and finally the chin successively passing over the anterior margin of the perineum. Immediately after its birth the head falls downward and the chin comes in contact with the region of the anus.

External Rotation.—A few moments after its birth the head undergoes another movement, and, when the occiput has been originally directed toward the left, it rotates toward the left tuber ischii, and in the opposite direction when it has been originally toward the right. This is known as external rotation or restitution, and is simply the index of a corresponding rotation of the body of the child, which serves to bring its bisacromial diameter into relation with the anteroposterior diameter of the pelvic outlet. This movement is brought about by essentially the same factors which produce the internal rotation of the head.

Expulsion.—Almost immediately after the occurrence of external rotation, the anterior shoulder appears under the symphysis pubis, and in a short time the anterior margin of the perineum becomes distended by the posterior shoulder, which is first born, being rapidly followed by the other. Finally, the body of the child is quickly extruded along a curved line corresponding to the axis of the lower part of the birth canal—that is, with its upper side markedly concave and its lower convex.

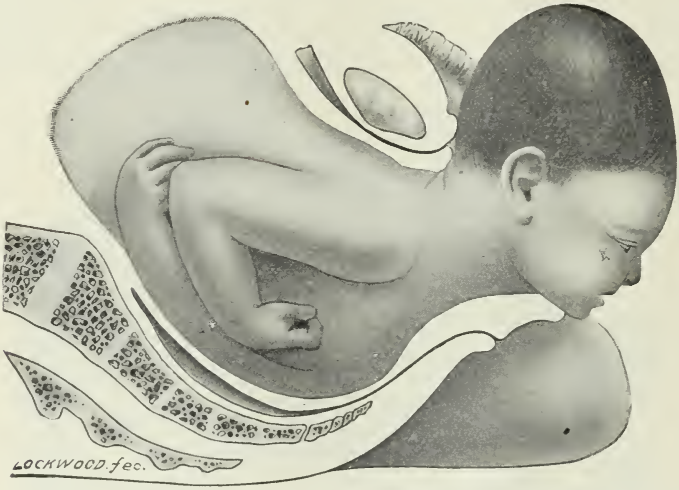


FIG. 274.—DIAGRAM SHOWING DELIVERY OF HEAD IN VERTEX PRESENTATION.

Mechanism in Occipitoposterior Presentations.—In 5488 cases of labor at the Johns Hopkins Hospital, in which the vertex presented, we observed 635 occipitoposterior presentations (11.3 per cent), the proportion in which the occiput was directed to the right or left being about 5 to 2. The number of primary occipitoposterior positions was probably twice as great as is here indicated, but, owing to the fact that many of our patients were not examined until well advanced in the second stage of labor, it happened in many cases that anterior rotation had already occurred.

Diagnosis.—Palpation in a right occipitoposterior presentation gives the following data:

First maneuver:	The fundus is occupied by the breech.
Second maneuver:	The resistant plane of the back is felt well back in the right flank, the small parts being on the left side and in front

and much more readily palpable than in anterior presentations.

Third maneuver: Negative if the head is engaged; otherwise the movable head is detected above the superior strait.

Fourth maneuver: Cephalic prominence on the left side (Plate XI).

Whenever the back of the child is felt on the right side of the mother, the possibility of a right posterior position should always be borne in mind, as it occurs much more frequently than the right anterior variety. It should also be remembered, whenever the small parts are distinctly felt in the anterior portion of the abdomen, that one has in all probability to deal with a posterior position, more especially in the rare instances in which the occiput has rotated into the hollow of the sacrum. In the less frequent left posterior positions palpation gives similar results, except that the back is felt in the left flank, and the small parts and cephalic prominence are found on the right side of the abdomen.

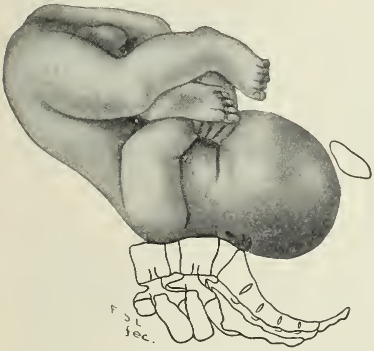


Fig. 275.—Diagram Showing Child in L. O. P.

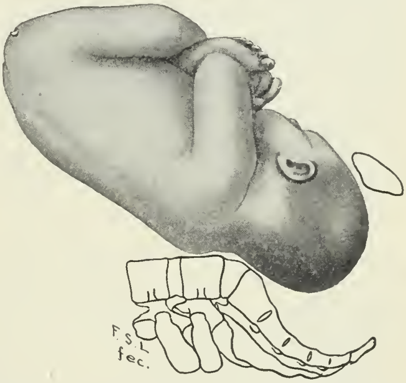


Fig. 276.—Diagram Showing Child in R. O. P.

On vaginal or rectal touch in the right posterior position, the sagittal suture occupies the right oblique diameter, the small fontanel is felt opposite the right sacro-iliac synchondrosis, the large fontanel being directed toward the left iliopectineal eminence; while in the left position the reverse obtains. In many cases, particularly in the early part of labor, owing to imperfect flexion of the head, the large fontanel lies at a lower level than in anterior positions, and is more readily felt.

On auscultation the heart is heard in the right or left flank of the mother, according as one has to deal with a right or left position. But it should be remembered that in these positions the heart sounds are sometimes transmitted through the thorax of the child, and the best heard either in the middle line or slightly to one side of it. This is due to a partial extension of the head and the altered relation of the body of the child, whereby the thorax comes in contact with the anterior uterine wall. Failure to realize this possibility sometimes results in serious diagnostic error.

Mechanism.—In the great majority of occipitoposterior presentations the mechanism of labor is identical with that observed in the anterior varieties, except that the occiput has to rotate from the region of the sacro-iliac synchondrosis to the symphysis pubis, instead of from the iliopectineal eminence—through 135 degrees instead of 45 degrees (Figs. 277 and 278).

In many instances internal rotation does not take place until the perineum begins to bulge, but occasionally it occurs only partially, or sometimes not at all, so that the occiput rotates only to a transverse or an obliquely anterior position, or remains obliquely posterior. In such circumstances spontaneous labor is out of the question unless the child is very small. Even in favorable cases considerable time is usually required for the completion of anterior rotation, so that there results a definite prolongation of labor. Varnier, upon comparing the histories in 400 cases of occiput posterior and in 660 cases of occiput anterior presentation, found that, in the former, labor averaged three hours and sixteen minues to one hour and fifty minutes longer, according as the patient was a primiparous or multiparous woman; although in my experience the prolongation is not so great.

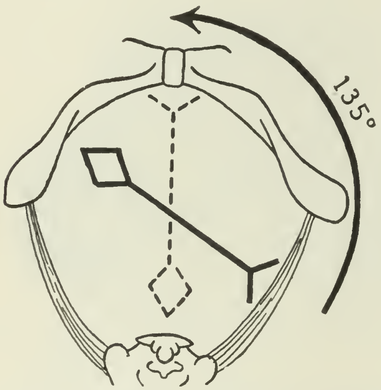


Fig. 277.—Diagram Showing Anterior Rotation from L. O. P.

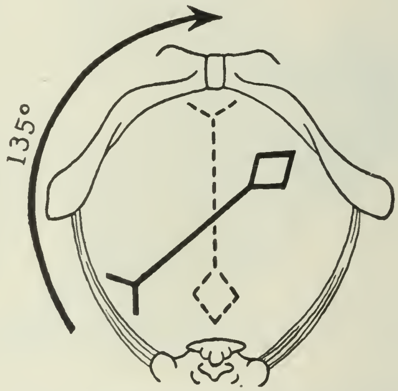


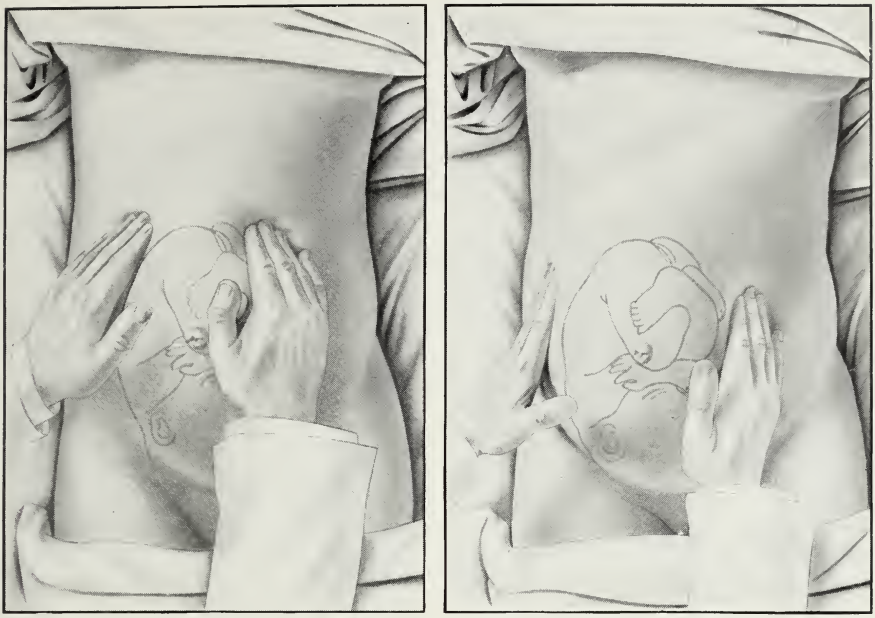
Fig. 278.—Diagram Showing Anterior Rotation from R. O. P.

In a small percentage of cases, particularly in women with funnel pelvis, the occiput, instead of rotating anteriorly or retaining its original position, turns spontaneously toward the sacrum, and eventually occupies its concavity. According to West and Varnier this occurs in 2 or 3 per cent of the cases, while we have noted a somewhat higher incidence in our obliquely posterior cases.

In many instances it is difficult to explain why anterior rotation fails to occur, but it may be stated as a general rule that it is much more likely to take place when the head is well flexed than when it is imperfectly flexed or partially extended. In the latter event the large fontanel occupies a lower level than the small, whence it would appear that it is usually the most dependent part of the head which rotates anteriorly.

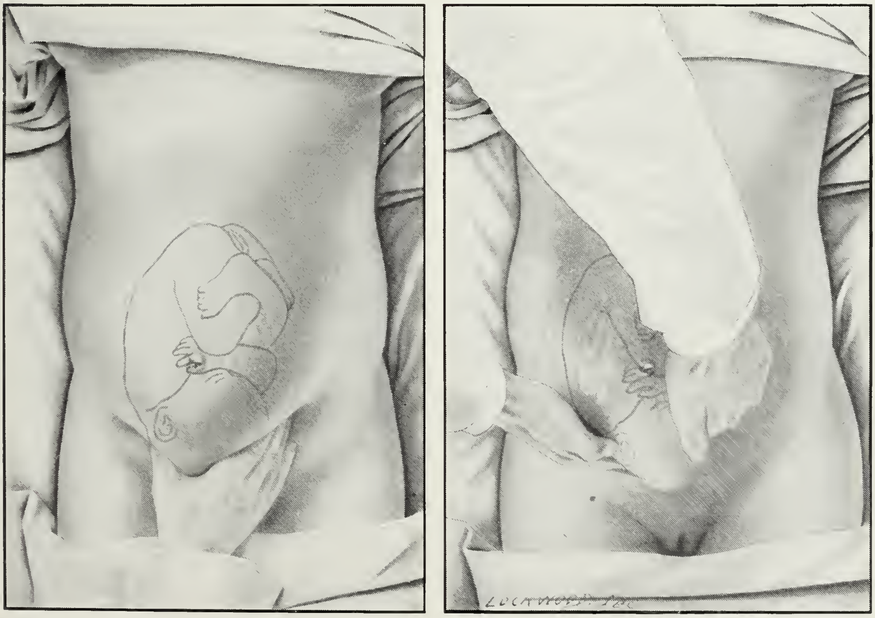
After the occiput has rotated into the hollow of the sacrum, the child may

PLATE XI.



First Maneuver.

Second Maneuver.



Third Maneuver.

Fourth Maneuver.

PALPATION IN RIGHT OCCIPITOPOSTERIOR PRESENTATION.

be born in one of two ways. Ordinarily, the head becomes markedly flexed and lengthened in its mento-occipital diameter so that eventually the region just anterior to the large fontanel impinges upon the lower margin of the symphysis pubis, after which the occiput is slowly pushed over the anterior margin of the perineum by a movement of flexion. Then by a movement of extension the occiput falls backward, and the brow, nose, mouth, and chin appear successively under the symphysis. After the birth of the head, external rotation and expulsion of the body occur in the usual manner.

According to Sentex, Winckel, Weiss, and Müller, the head is occasionally born by another mechanism, which comes into play in those cases in which partial extension persists. In such circumstances the brow appears at the vulva, and, while the root of the nose impinges upon the symphysis, by a movement of flexion the brow, bregma, and occiput successively pass over the perineum, until finally the face slips out from under the symphysis pubis. This mechanism approaches closely to that observed in brow presentations, and is much more difficult than the one just described, and is more liable to lead to tears of the maternal soft parts, since it is evident that in the first instance the vulva is distended by the suboccipitofrontal circumference of the head, and in the second by the occipitofrontal, which measure 34 and 37 centimeters, respectively.

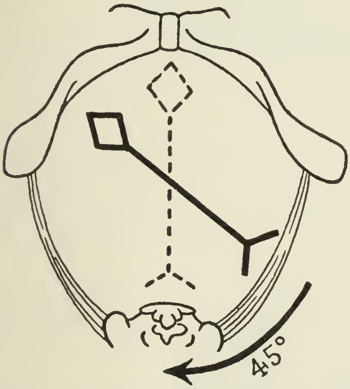


Fig. 279.—Diagram Showing Posterior Rotation from L. O. P.

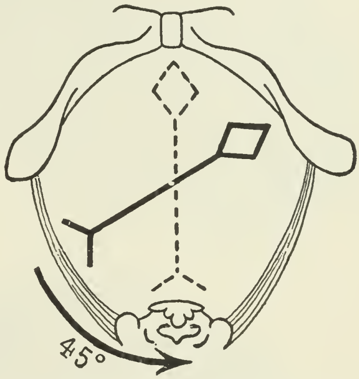


Fig. 280.—Diagram Showing Posterior Rotation from R. O. P.

It is generally believed that occipitoposterior offer a much more gloomy prognosis than occipito-anterior presentations. This is probably due to the fact that Mauriceau, Smellie, and all the early authorities taught that in such cases the occiput always rotated into the hollow of the sacrum, and that later many American writers, being led astray by their fears, have failed to realize what Nature can accomplish. It is true that Naegele showed that in the vast majority of cases the occiput rotated anteriorly, but in spite of his teachings, the older views still prevail. Thus Capuron, in 1833, taught that spontaneous delivery could not take place; and Tarnier, while admitting the correctness of Naegele's conclusions, nevertheless held that the prognosis was always serious, for, even when anterior rotation occurred, the duration of labor was greatly increased and the maternal and fœtal mortality augmented.

A comparatively large experience has led me to discount these gloomy views, and to regard the occurrence of obliquely posterior presentations with equanimity, provided the pelvis and child are normal in size. Moreover, in view of our uniformly good results, I do not consider it advisable to attempt to convert them into other positions during the course of labor, except when the forceps is to be applied. It is true that labor is somewhat prolonged, and instrumental interference is required more frequently—in 10 per cent of the cases, according to

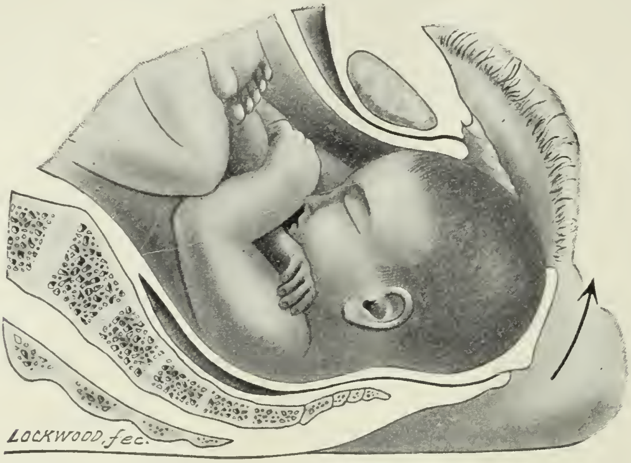


Fig. 281.—Usual Mechanism of Delivery of Head with Occiput in Hollow of Sacrum.

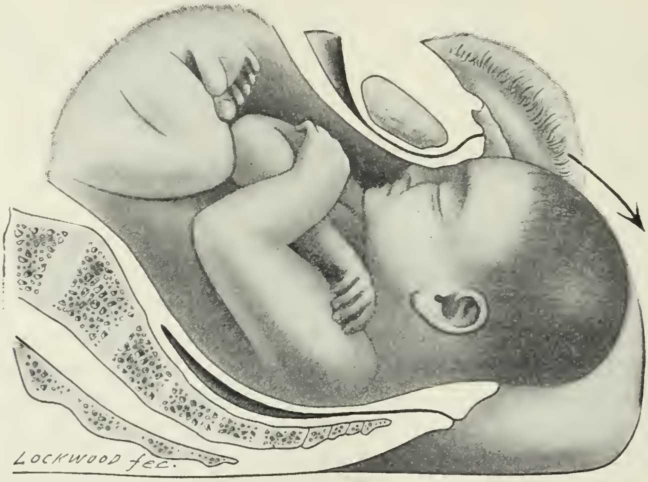


Fig. 282.—Usual Mechanism of Delivery of Head with Occiput in Hollow of Sacrum.

Varnier, as compared with 3.6 per cent in anterior presentations. Even when only partial rotation occurs, so that one has to deal with the so-called "deep transverse arrest," the prognosis is excellent provided the forceps are applied to the sides of the head as will be described in Chapter XX. In 635 of our cases, reported by Plass in 1916, in which delivery occurred spontaneously or was aided by forceps, we had no maternal mortality attributable to the posterior position, and the fœtal mortality was not appreciably increased over that occurring in obliquely anterior presentations.

Even in the comparatively rare instances in which posterior rotation occurs so that the occiput comes to lie in the hollow of the sacrum, the prognosis is not bad, as in the majority of cases spontaneous delivery occurs, being noted by Varnier in 30 out of 35 cases. No doubt, in such cases there is an increased tendency toward perineal tears, which is particularly marked when the head is born by the less frequent mechanism. But to my mind the main cause of the dread in which posterior presentations are held is the fact that they frequently escape recognition, with the result that the large number which rotate anteriorly and end spontaneously are overlooked, and only those cases are recognized in which rotation either fails to occur, deep transverse arrest results, or the occiput rotates into the hollow of the sacrum. Furthermore, these conditions are usually not diagnosticated until operative interference becomes necessary, and even then not until repeated failure at forceps extraction leads to careful examination and to the recognition that the instrument had been applied improperly—that is, to the sides of the pelvis.

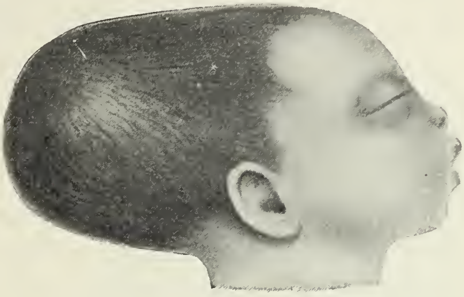


Fig. 283.

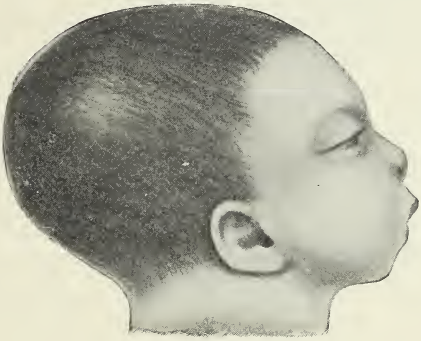


Fig. 284.

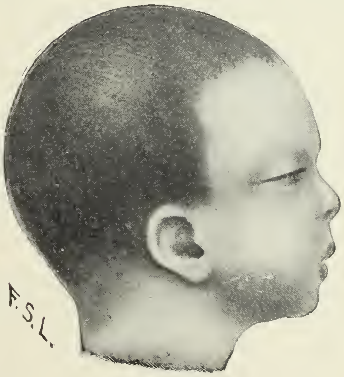


Fig. 285.

Figs. 283-285.—Caput Succedaneum at Birth; Its Disappearance Three and Ten Days Later.

When in occipitoposterior presentations the head has descended into the pelvis, it is my practice to leave the case to Nature as long as possible, and to interfere only when absolutely indicated by the objective condition of the mother or child. But when convinced that their best interests will be served by prompt delivery, forceps should be applied according to the directions which will be given in the appropriate chapter. On the other hand, when the head is arrested at the superior strait in a posterior position, with the cervix fully dilated, version should be resorted to as soon as one is convinced that spontaneous advance will not occur, provided, of course, that the operation is not contraindicated by disproportion between the size of the head and the pelvis.

In my hands, attempts to remedy the position by altering the posture of the patient, as recommended by many writers, have proven uniformly unsuccessful. Finally, I regard as little short of criminal the resort to cesarean section in this type of case, unless such disproportion exists as would justify it, irrespective of the position of the child.

Changes in the Shape of the Head.—In vertex presentations the child's head undergoes important and characteristic changes in shape, as the result of the pressure to which it is subjected during labor. In prolonged labors in which the membranes have ruptured before complete dilatation of the cervix, the portion of the head immediately over the os is relieved from the general pressure existing in the uterus, and, as a consequence, a serous exudate occurs under the scalp at this point, causing a soft swelling, known as the *caput succedaneum.* Usually this attains a thickness of only a few millimeters, but in prolonged labors it may become so considerable as to prevent the examining finger from distinguishing the various sutures and fontanels. More usually the caput is formed when the head is in the lower portion of the birth canal, and frequently only after the resistance of a rigid vaginal outlet is encountered. It occurs upon the most dependent portion of the head, and therefore in left occipito-iliac positions is found over the upper and posterior extremity of the right parietal bone, and in right positions over the corresponding area of the left parietal bone. Hence it follows that in many instances after labor we are enabled to diagnose the original presentation by the situation of the caput succedaneum. When this is lacking, Sellheim has pointed out that similar information may be obtained by noting the direction in which the hair of the child has been "brushed" during the movement of internal rotation.

More important, however, are the plastic changes which the head undergoes. Owing to the fact that the various bones of the skull are not firmly united, movement may occur at the various sutures. Ordinarily the margins of the occipital bone, and more rarely those of the frontal bone, are pushed under those of the parietal bones; and in many cases one parietal bone may overlap the other, the rule being that the one occupying the posterior position is overlapped by the anterior. These changes are of great importance, especially in contracted pelves, when the ability of the child's head to become molded may make the difference between a spontaneous labor and a major obstetrical operation.

As a result of pressure the head also undergoes a marked change in shape, which consists in a diminution of its suboccipitofrontal and occipitofrontal diameters. In other words, it becomes lengthened from chin to occiput and compressed in other directions. This is clearly shown in Fig. 286.

In occipitoposterior presentations, when the occiput has rotated into the hollow of the sacrum, the frontal bone is sometimes markedly overlapped by the anterior margins of the parietal bones, which leads to a distinct depression of that part of the head, and give some idea of the force with which the region of the large fontanel has been pressed against the lower margin of the symphysis.

Such pressure changes are of much more serious import than was formerly believed, and it is now known that they may play an important part in the production of fatal subdural hemorrhage. Holland, in his important work upon cranial stress during labor, has shown that they subject the tentorium cerebelli or the falx to excessive tension, which may result in actual lesions associated with hemorrhage, and which readily account for many fœtal deaths which were formerly considered inexplicable.

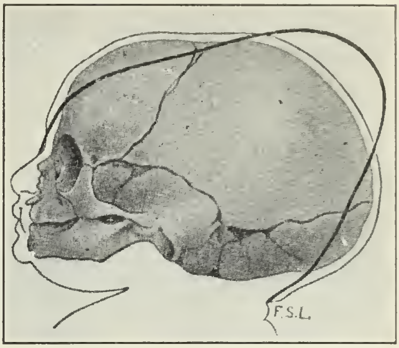


Fig. 286.—Diagram Showing Configuration of Head in Vertex Presentation (American Textbook).

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CHAPTER XIII

MECHANISM OF LABOR IN FACE, BROW, AND BREECH PRESENTATIONS

Face Presentations.—In face presentations the head is sharply extended, so that the occiput is in contact with the back, while the face looks downward. Markoe, and Pinard, upon analyzing 51,635 and 92,026 cases of labor, found that the incidence of such presentations was 0.48 and 0.4 per cent, respectively —that is, 1 to every 207 or 250 labors.

The face most frequently occupies the right oblique diameter of the pelvis, so that the chin is directed either toward the left iliopectineal eminence or the right sacro-iliac synchondrosis. Accordingly, the left mento-anterior and right mentoposterior are the varieties usually observed, and together they constituted 62.4 per cent of Markoe's 250 cases.

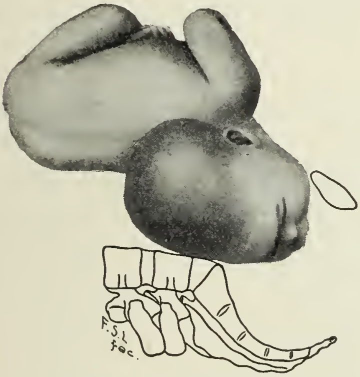


Fig. 287.—Diagram Showing Position of Child in L. M. A.

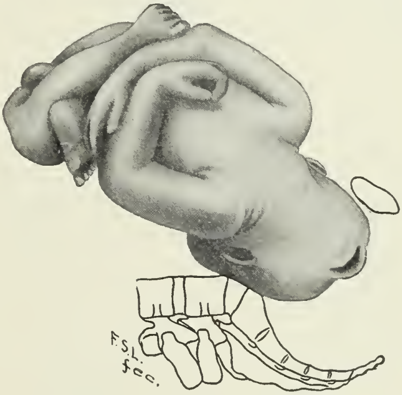


Fig. 288.—Diagram Showing Position of Child in R. M. A.

It is generally stated that face presentations do not exist during pregnancy, but owe their origin to extension of the head at the superior strait at the onset of labor, although Mme. LaChapelle, Naegele, Spiegelberg, Ribemont-Dessaignes, Fieux, and others have described instances in which they were diagnosticated during pregnancy. These are designated as primary, in contradistinction to the much more frequent secondary face presentations.

Diagnosis.—In the left mento-anterior variety palpation gives the following data:

First maneuver: Breech in fundus.
Second maneuver: Back in the right and posterior portion of the abdomen, and distinctly felt only in its upper portion; small parts in left and anterior portion of the abdomen.
Third maneuver: Marked cephalic prominence on right side.
Fourth maneuver: Marked cephalic prominence on right side; fingers can be depressed deeply on left.

The reverse holds good in the right posterior variety (Plate XII). The characteristic sign is that the cephalic prominence is palpable on the same side as the back, instead of on the side of the small parts as in vertex presentations. The back is felt distinctly only in the neighborhood of the breech.

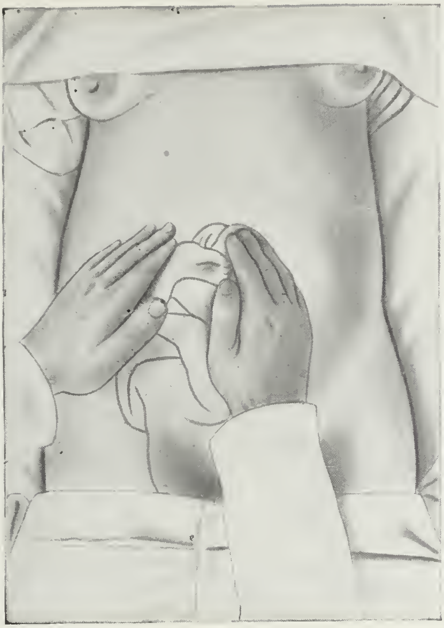
On vaginal or rectal touch the face is found in the birth canal, and the variety of presentation is diagnosticated by the differentiation of the various features, the mouth and nose, malar bones, and orbital ridges being the distinctive points. In the left anterior variety the chin occupies the anterior and the brow the posterior extremity of the right oblique diameter of the pelvis, while in right posterior position the reverse obtains.

The heart sounds are transmitted through the thorax; accordingly they are heard through the side of the abdomen which contains the small parts and generally below the umbilicus. The only other condition in which auscultation gives similar results is in brow presentations and in the rare cases of occipitoposterior presentations in which the head is partially extended.

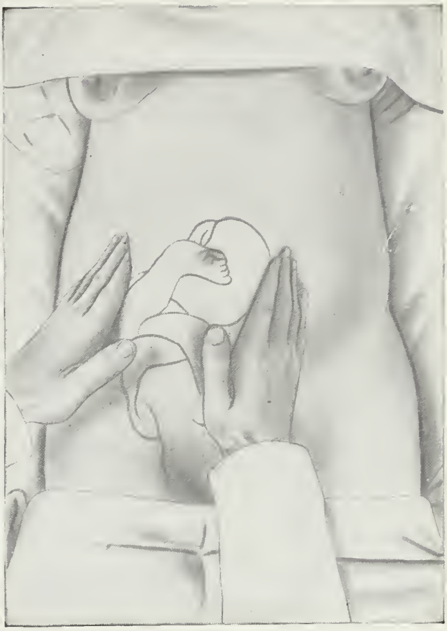
Causation.—The causes of face presentations are manifold, and, roughly speaking, are afforded by any factor tending to bring about extension or to prevent flexion of the head. Accordingly, they occur more frequently when the pelvis is contracted or the child very large. It is therefore an excellent practical rule to bear the latter possibility in mind whenever one meets with lack of engagement in a normal pelvis. Petitjean believes that the production of face presentation is favored by a low implantation of the placenta, which he has noted in two-thirds of the cases observed in Pinard's clinic.

To Matthews Duncan belongs the credit of having directed attention to the most frequent causative factor concerned in the production of secondary face presentations—namely, an oblique position of the uterus, which permits the child's back to sag toward the side in which the vertex lies. He pointed out that in such circumstances the attitude of the fœtus becomes abnormal, so that a slight obstacle to the descent of the posterior portion of the head will result in its extension. This occurs most frequently in right occipitoposterior presentations, as is shown by the fact that, while left occipito-anterior are many times more frequent than right occipitoposterior presentations, the same two varieties of face presentation occur with almost equal frequency. That multiparity would naturally favor the production of this condition is evident, since lax abdominal walls allow the uterus to assume an oblique position. Thus Pinard and Winckel state that 60 per cent of their cases occurred in multiparous women.

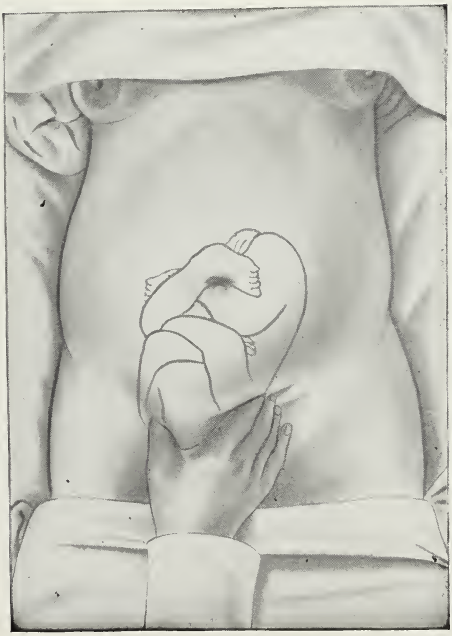
PLATE XII.



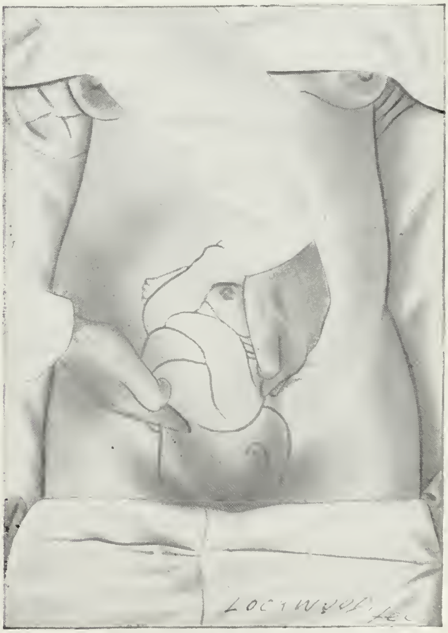
First Maneuver.



Second Maneuver.



Third Maneuver.



Fourth Maneuver.

PALPATION IN RIGHT MENTO-ANTERIOR PRESENTATION.

In exceptional instances, marked enlargement of the neck or thorax, coils of cord about the neck, spastic contraction, or congenital shortening of the cervical muscles may cause extension (Morse). Again, it is well known that anencephalic children usually present by the face, as the result of the faulty development of the cranial vault.

Hecker pointed out that primary face presentations are occasionally due to an elongation of the occiptal portion of the head—*dolichocephalus*. There is no doubt that most children that are born by the face have heads of this character, but the fact that the normal shape becomes restored a few days after labor shows beyond question that the deformity is the result, rather than the cause, of the presentation. Zweifel delivered by cesarean section a dolichocephalic child, which had presented by the breech, and held that the observation demonstrated the primary nature of the dolichocephalus; but Fritsch and others contend that the peculiar shape of the head resulted from pressure exerted upon it by the fundus of the uterus. On the other hand, Jellinghaus and Gessner have reported cases which they believe support the original theory of Hecker; and, on the whole, it would seem probable that such a condition may occasionally bear a causal relation to face presentations.

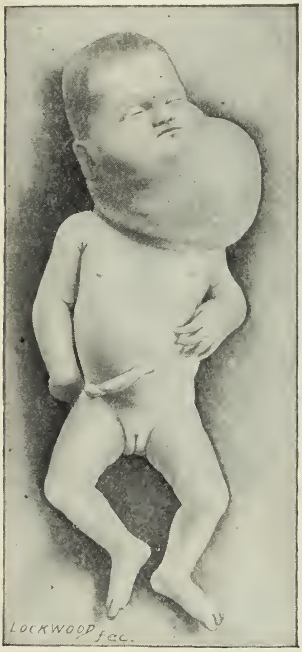


FIG. 289.—TUMOR OF NECK CAUSING FACE PRESENTATION.

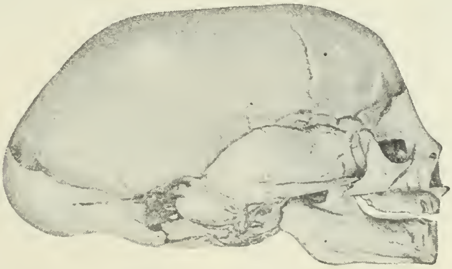


FIG. 290.—DOLICHOCEPHALIC HEAD FROM BREECH PRESENTATION (Jellinghaus).

Mechanism.—As face are usually derived from vertex presentations, it is apparent that the former are but rarely observed in a fully developed state at the superior strait, where the brow generally engages, while the face descends only after further extension.

The mechanism in these cases consists of the *cardinal movements*—descent, internal rotation and flexion; and the *accessory movements*—extension and external rotation. *Descent* is brought about by the same factors as in vertex presentations, while *extension* results from the relation which the body of the child bears to its deflected head, the latter being converted as it were into a two-armed lever, the longer arm of which extends from the occipital condyles to the occiput; so that when resistance is encountered the latter must be pushed upward, while the chin descends (Fig. 291).

Internal rotation has for its object the rotation of the face in such a manner as to bring the chin under the symphysis pubis, since otherwise natural delivery cannot be accomplished. Only in this way can the neck substend the posterior surface of the symphysis pubis; whereas, if the chin rotates directly posteriorly, the relatively short neck cannot span the anterior surface of the sacrum, which measures 12 centimeters in length, so that the birth of the head is manifestly impossible unless the shoulders can enter the pelvis at the same time, which is out of the question except when the child is premature or macerated (Fig. 292). Internal rotation is due to the same factors as in vertex presentations, and Sellheim holds that as bending in face presentations occurs most readily between the base of the neck and the chin, that portion of the child must inevitably rotate to the front in order to accommodate itself to the "knee" of the birth canal.

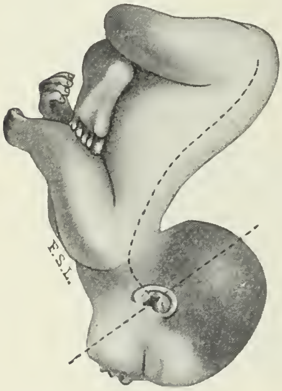


FIG. 291.—DIAGRAM SHOWING THAT IN FACE PRESENTATIONS THE OCCIPUT IS THE LONG END OF HEAD LEVER.

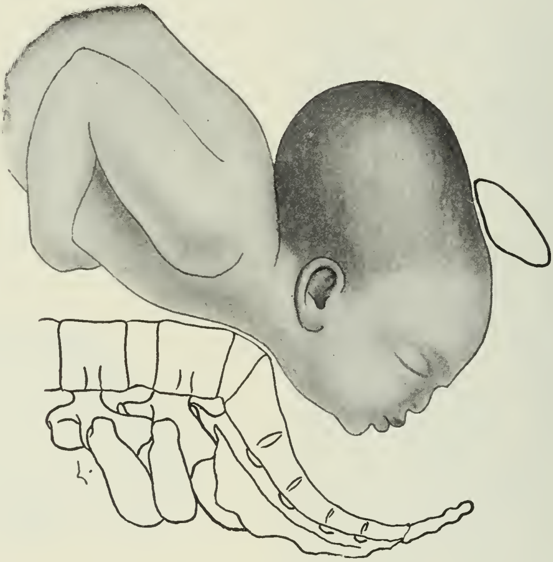


FIG. 292.—DIAGRAM ILLUSTRATING IMPOSSIBILITY OF LABOR IN FACE PRESENTATIONS WHEN THE CHIN HAS ROTATED DIRECTLY POSTERIOR.

After anterior rotation and descent the chin and mouth appear at the vulva; the under surface of the chin becomes stemmed against the symphysis, and the head is delivered by a movement of *flexion,* the nose, eyes, brow, bregma, and occiput appearing in succession over the anterior margin of the perineum (Figs. 294, 295 and 296). After the birth of the head the occiput sags backward toward the anus, and in a few moments the chin, by a movement of external rotation, turns to the side toward which it was originally directed, after which the shoulders are born as in vertex presentations.

In a small number of cases internal rotation, instead of occurring anteriorly, may take place toward the hollow of the sacrum, or, occasionally, as was pointed out by Hodge, the face may engage primarily in this manner. In such circumstances, for the reasons given above, the birth of a normal-sized child is usually impossible. Reed, in 1905, has shown that such a view is somewhat too extreme, for, after reviewing 75 cases of persistent mentoposterior presentations reported in the literature, he found that 17 had been delivered without change of presenta-

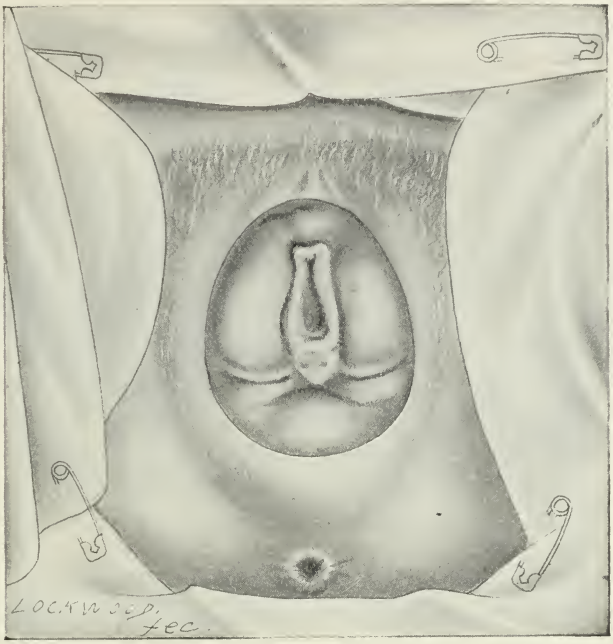


Fig. 293.—Distention of Vulva in Face Presentation (modified from Ahlfeld).

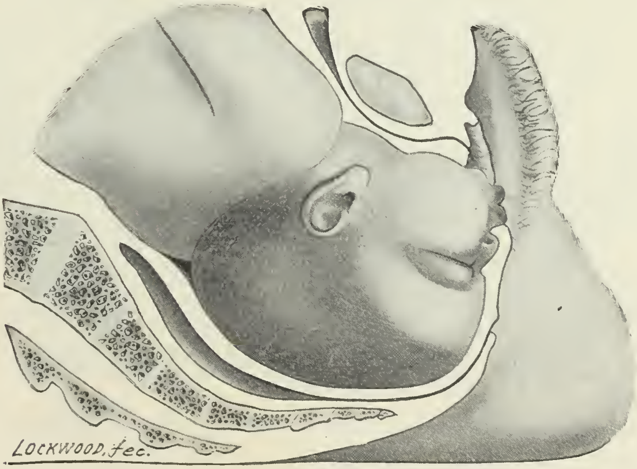


Fig. 294.—Diagram Showing Delivery of Head in Face Presentation.

tion. This, however, should not be taken as indicating that such positions are not very serious, as in the entire series 11.6 per cent of the mothers and 40.6 per cent of the children perished.

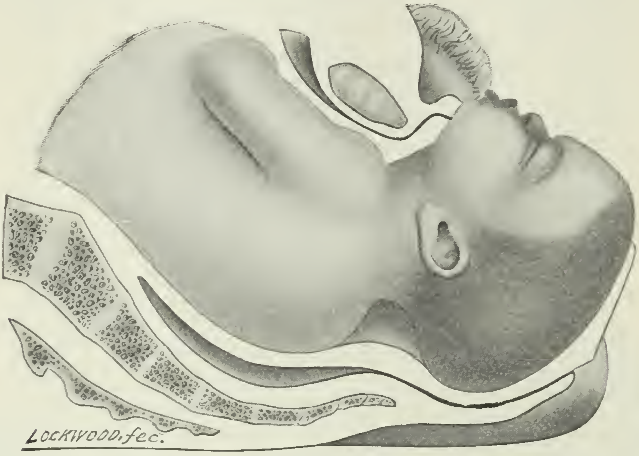


FIG. 295.—DIAGRAM SHOWING DELIVERY OF HEAD IN FACE PRESENTATION.

In mental presentations the face becomes distorted owing to the effusion of serum beneath the skin, which when marked completely obliterates the features and may readily cause confusion with a breech presentation. At the same time the skull undergoes considerable molding, which is manifested by an increase in length of the mento-occipital diameter and a diminution in the vertical diameters of the head.

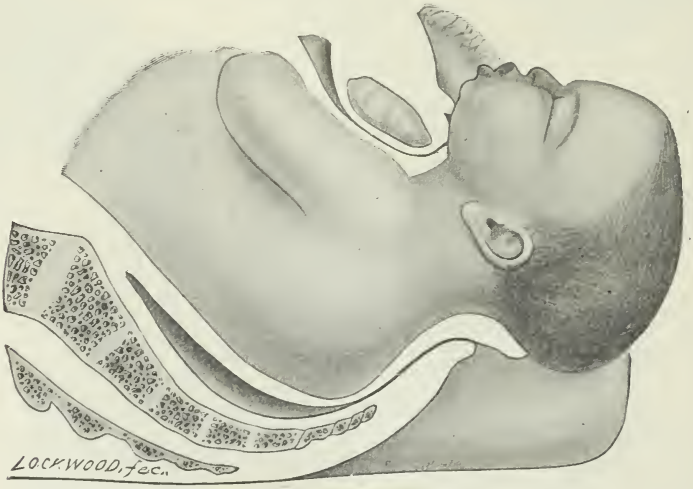


FIG. 296.—DIAGRAM SHOWING DELIVERY OF HEAD IN FACE PRESENTATION.

Prognosis.—Until the latter part of the eighteenth century face presentations were considered extremely unfavorable, and most authorities advised their conversion into some other variety. But about that time Deleurye, in France, and Zeller and Boer, in Austria, pointed out that most of them would end spontaneously if left alone. This doctrine was definitely established by Johann Lucas Boer, who reported that he had observed spontaneous labor in 79 out of a series of 80 face presentations, and had applied forceps in only a single instance.

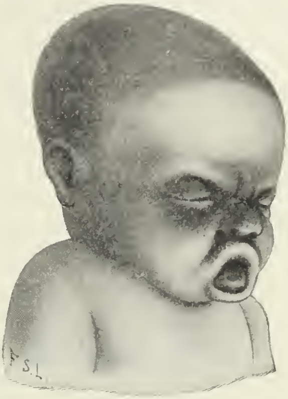


Fig. 297.—Showing Distortion of Face after Delivery in Face Presentation.

Deep tears of the perineum are of frequent occurrence, and are ofttimes erroneously attributed to excessive distention of the vulval outlet by the largest circumference of the head—the mento-occipital. In reality, however, the trachelobregmatic is the circumference concerned, and as it is but little larger than the suboccipitofrontal, which is concerned in vertex presentations, some other factor must be invoked to explain the greater incidence of perineal tears. This probably consists in the greater downward protrusion of the pelvic floor, as in face presentations the presenting part must descend very deeply before flexion of the neck under the symphysis can occur.

Owing to the prolongation of labor the fœtal mortality is markedly increased, being usually estimated at about 14 per cent. Markoe's mortality was 21 per cent, while Weiss lost only 4 out of 78 children (5.1 per cent).

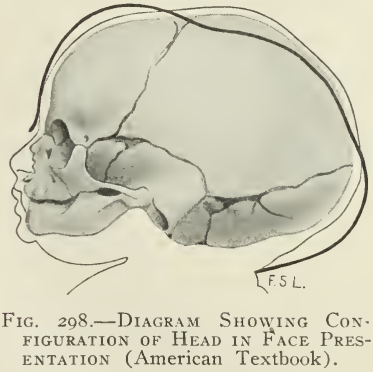


Fig. 298.—Diagram Showing Configuration of Head in Face Presentation (American Textbook).

In dealing with face presentations it should always be borne in mind that internal rotation does not occur until the pelvic floor is well distended by the advancing face; and frequently, when the chin is obliquely posterior, it may not take place until the obstetrician has almost abandoned hope of its occurrence. Nor should it be forgotten that the face must occupy a lower level than the vertex before one can feel assured that the greatest circumference of the head has passed through the superior strait. This can be readily appreciated from a study of Figures 299 and 300, in which it is seen that the distance from the parietal boss to the vertex is only 3 centimeters, whereas a line drawn from the same point to the face will measure 7 centimeters.

Treatment.—In the anterior varieties spontaneous delivery is the rule, and, even when the chin is obliquely posterior, anterior rotation usually occurs, although often not until a very late period. In view of the serious prognosis attending failure of the chin to rotate anteriorly and particularly when the face rotates into the hollow of the sacrum, an attempt should be made to substitute a vertex presentation. When the face is not deeply engaged, provided there exists no disproportion between its size and that of the pelvis and the amniotic fluid has not long since drained away, this can sometimes be readily accomplished, either by pushing up the chin or by making traction upon the occiput.

On the other hand, when the chin is directed anteriorly, attempts at conversion are not advisable, as they would merely substitute an occipitoposterior position, which is but slightly more favorable than the original face presentation, not to speak of the increased danger of infection attending the manipulation. In obliquely posterior face positions, on the contrary, conversion is indicated, and should be attempted as soon as the condition is recognized and the degree of dilatation of the cervix permits. If it cannot be readily effected, internal podalic version becomes the operation of choice.

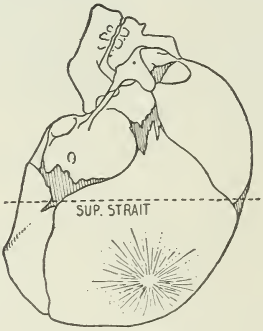


Fig. 299.—Diagram Showing that when the Vertex is on the Line Joining the Ischial Spines, the Greatest Diameter of the Head has Passed the Superior Strait.

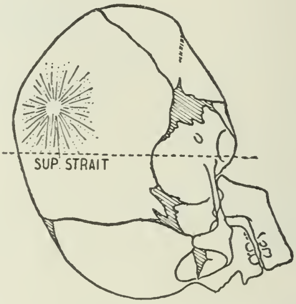


Fig. 300.—Diagram Showing that when the Face is on the Level of the Ischial Spines, the Greatest Diameter of the Head is Still Above the Superior Strait.

From time to time numerous methods of conversion have been suggested, the oldest and most effectual being the following, advocated by Baudelocque and revived by Thorn, Weiss, and others: Attempts are made to push up the chin by two fingers introduced into the vagina; if this does not succeed the patient is anesthetized, the whole hand introduced, and the head dislodged, after which the vertex is grasped and drawn down. At the same time the external hand of the operator or the assistant carries the back in the opposite direction, so as to facilitate flexion. Very excellent results have been obtained by this maneuver, and its adoption in suitable cases can be recommended.

Schatz suggested the method of external manipulation, pictured in many textbooks, by which the vertex is substituted for a presenting face. This, however, is rarely available, inasmuch as the presentation does not become well developed until after engagement has occurred.

If the face be too deeply engaged in the pelvis to admit of the Baudelocque maneuver, the patient should be let alone and descent allowed to take place, in the hope that anterior rotation will occur when the face reaches the pelvic floor. If, however, this does not take place after a reasonable delay, and symptoms supervene which indicate the termination of labor, manual rotation should be attempted, and if this cannot be effected forceps should be applied in the manner to be described later, and an attempt made to rotate the chin to an anterior position; finally if this fails, the only resource lies in pubiotomy or craniotomy, as conservative cesarian section should not be considered on account of its high maternal mortality when done so late in labor.

When the chin is originally situated directly posteriorly, or has rotated into that position, internal podalic version should be performed as soon as the condition of the cervix will permit, provided the face is not too deeply engaged or the uterus so tightly contracted about the child as to contra-indicate it. On the other hand, if the face be so firmly engaged that it cannot be pushed up under anesthesia, craniotomy or pubiotomy must be resorted to as soon as the patient's condition calls for delivery. The former has been repeatedly practiced, and Morse collected the few cases in which pubiotomy has been performed up to 1912, including two successful operations done in this clinic.

Brow Presentations.—In brow presentations the head occupies a position midway between flexion and extension; hence the portion situated between the orbital ridge and large fontanel presents at the superior strait. As nearly every child which is born by the face has gone through a preliminary stage of brow presentation, the latter must occur more frequently, later undergoing spontaneous conversion into either a face or a vertex presentation. On the other hand, persistent brow presentations are extremely rare, and are generally stated to occur once in every 1500 to 2000 cases, though Weiss and Markoe observed one example in every 1000 labors.

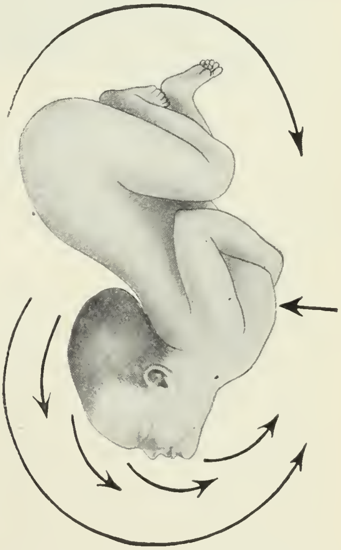


Fig. 301.—Diagram Showing Direction of Pressure in Conversion of a Face into a Vertex Presentation by Thorn's Maneuver.

The causes of this presentation, which have been carefully studied by Ahlfeld, and Neumann, are practically identical with those giving rise to face presentations, and depend upon any factor which interferes with flexion or promotes extension of the head. The latter, in 1929, pointed out that heads of a certain shape predispose to the occurrence of brow presentations—notably hypsicephalus and oxycephalus, in which the head is tower-shaped or conical. In twin pregnancies not infrequently one or both children may present in this manner, and Ahlfeld maintains that the anterior surfaces of the two fœtuses coming in contact mutually disturb the normal flexed attitude, so that extension is facilitated. Usually the brow is directed toward one or other extremity of the transverse diameter of the superior strait.

Diagnosis.—The presentation can occasionally be recognized by palpation but vaginal touch is usually necessary, as the data obtainable from the former are less characteristic than in the more common presentations. The palpatory findings are similar to those observed in face presentations, except that the cephalic prominence is less marked on the side of the back, while the resistance offered by the chin can be felt on the same side as the small parts. On vaginal or rectal touch the frontal suture and the anterior portion of the sagittal suture are encountered in the transverse diameter, at one end of which the large fontanel or the portion of the skull just posterior to it may be felt; while at the other the orbital ridges, the root of the nose, and the eyes may be distinguished. It is not possible to palpate the mouth or chin, for when these are within reach we have to deal with a face presentation.

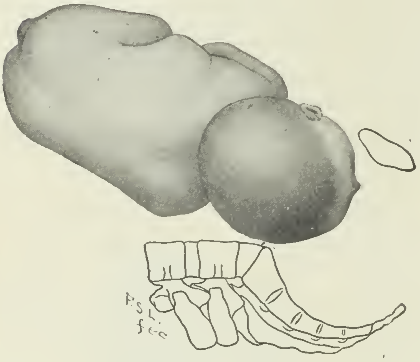


Fig. 302.—Diagram Showing Position of Child in Right Anterior Brow Presentation.

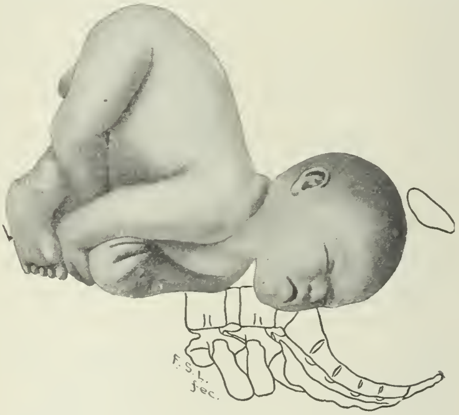


Fig. 303.—Diagram Showing Position of Child in Left Posterior Brow Presentation.

Mechanism.—The mechanism of labor in brow presentations differs materially with the size of the fœtus, which Ahlfeld and most observers have stated is usually below the normal. Weiss and Neumann, on the other hand, maintain that large children are the rule. In the former case the course of labor, as a rule, is easy, while in the latter it is usually very difficult. The cause of the difficulty is apparent when we consider that the circumference of the head which engages at the superior strait is the mento-occipital, whose greatest diameter averages 13.5 centimeters in length; consequently engagement is impossible until after marked molding has taken place, by which the mento-occipital diameter has become diminished and the fronto-occipital increased in length.

After molding and descent have occurred the brow sometimes rotates anteriorly, and the forehead, orbital ridges, and root of the nose appear at the vulva. One of the superior maxillary bones then becomes stemmed against the inferior margin of the symphysis, and the rest of the head is born by a movement of extreme flexion, the brow, bregma, and occiput appearing in succession over the anterior margin of the perineum. After the birth of the occiput, the mouth and chin descend from behind the pubic arch by a movement of extension. In other words, we have a mechanism somewhat similar to that observed in the less frequent mode of delivery in the case of posterior occiput presentations which had rotated into the hollow of the sacrum. Sometimes, however, as reported by Bretz, Fink, and Neumann, the brow descends to the outlet with the frontal suture directly transverse, and is born in that position; or partial anterior rotation occurs, bringing the root of the nose to about the middle of the ischiopubic ramus, when the occiput is delivered posteriorly by a movement of extreme flexion, after which the face escapes following extreme extension. In either event, the second stage tends to be unduly prolonged.

As has already been pointed out, a large child cannot enter the birth canal without considerable molding of the head. This adds materially to the length of labor and results in the birth of children with characteristically deformed heads. The caput is found over the forehead and extends from the orbital ridges to the large fontanel, and in many cases is so marked as to render diagnosis by vaginal touch almost impossible. In these cases, as is shown in Figure 304, the forehead is very prominent and square, the mento-occipital diameter being diminished and the fronto-occipital diameter increased in length.

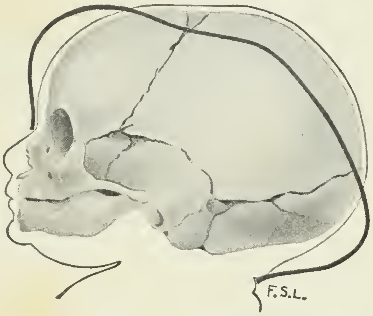


Fig. 304.—Diagram Showing Configuration of Head in Brow Presentation (American Textbook).

Prognosis.—In the transient varieties of brow presentation, the outlook depends upon the presentation which ultimately results, and whether the face or vertex enters the birth canal; while in the persistent forms it is generally considered to be bad, unless the fœtus be small. It should always be remembered that disproportion between the size of the head and the pelvis is an important factor in the production of such presentations, so that under identical mechanical conditions the possibility of a spontaneous outcome is always much less in a brow than in a vertex presentation. Fink reports that in a series of 130 brow presentations, spontaneous delivery occurred in only 43 per cent of the patients.

Rational methods of treatment, similar to those indicated in face presentations, and more particularly stricter attention to aseptic technic have led to a marked improvement in the prognosis of the persistent varieties. Thus, Markoe recorded a fœtal mortality of 39 per cent, while Weiss, on the other hand, has reported 29 cases, without a death of fœtus or mother.

Treatment.—If the brow be recognized at the superior strait, the treatment will vary according as the presentation promises to be transient or persistent.

The former should be left alone, as the child will probably be born spontaneously by the vertex or face. On the other hand, in persistent cases, particularly if the brow be obliquely posterior, attempts at conversion should be made as soon as the cervix is fully dilated. If they are not successful, version should be performed, if feasible, as recommended in face presentations. On the other hand, if the brow be deeply engaged, conversion should not be attempted unless one is able to push the presenting part up to the level of the superior strait, without difficulty, when the treatment is identical with that outlined above. But if this cannot be accomplished, version is also out of the question, and the case should be left to nature, and forceps applied when indicated by the condition of the mother or child, and followed by craniotomy if necessary. It should be remembered, however, that delivery in these circumstances is nearly always associated with considerable injury to the maternal soft parts, owing to the large circumference of the fœtal head by which they are distended. Wallich has made an earnest plea for the performance of symphyseotomy in persistent brow presentations, and has reported 7 operations with no maternal and only 2 fœtal deaths. In my opinion late cesarean section is rarely indicated, because of its high maternal mortality, and, if undertaken, should be followed by supravaginal hysterectomy. On the other hand, if section is done early in labor it should be on account of the pelvic indication, rather than because of the abnormal presentation.

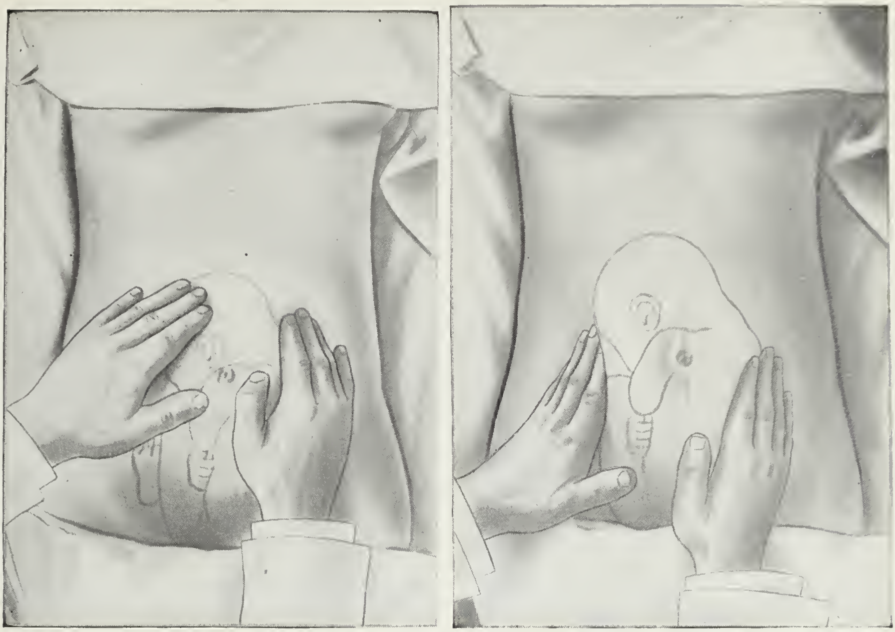
Breech Presentations.—As has already been pointed out, the relation between the lower extremities and buttocks of the child is not always the same in sacro-iliac presentations, and we therefore distinguish between frank breech, complete breech, foot and knee presentations. In all these varieties, however, the mechanism of labor is essentially the same, so that they need not be considered separately.

Usually the breech engages in such a manner that the sacrum is directed to the left side of the mother, and accordingly the left sacro-anterior or posterior are the positions most frequently observed.

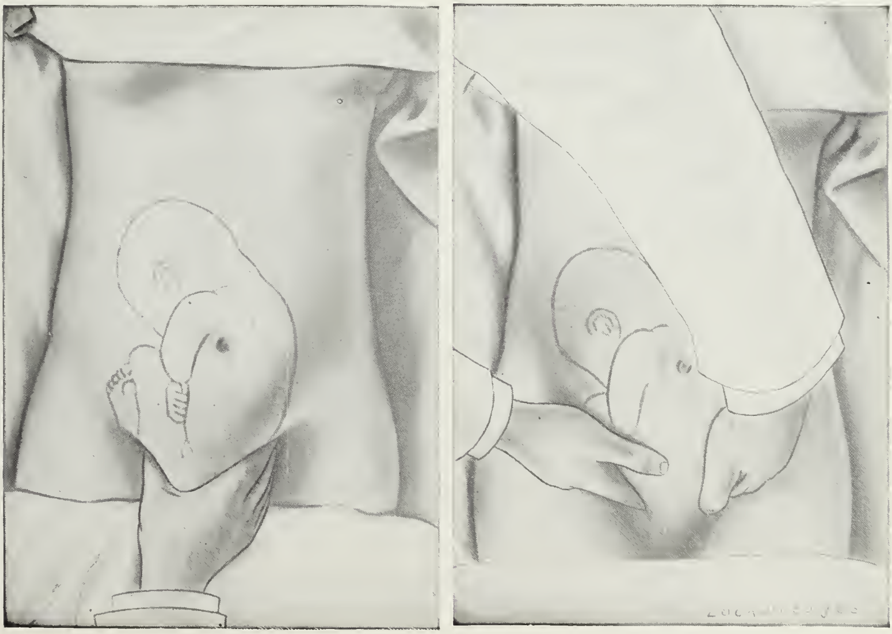
In 100,000 cases of labor Pinard observed 3301 breech presentations—about 3.30 per cent. These statistics include premature as well as full-term labors, but, if the latter alone are considered, the incidence would be somewhat less.

Diagnosis.—On palpation, the first maneuver reveals a hard, round, readily ballottable body occupying the fundus of the uterus, and when the abdominal walls are very thin one can occasionally obtain a characteristic cracking sensation upon compressing the bones of the skull. By the second maneuver the back is found to occupy one side of the abdomen and the small parts the other, position and variety being determined by the location of the former. On the third maneuver, if engagement has not occurred, the irregular breech is freely movable above the superior strait; while, if it has already occurred, the fourth maneuver shows that the pelvis is filled by a soft mass which interferes with the penetration of the fingers (Plate XIII). Kautsky has made the interesting observation that in breech presentations a distinct slowing in the fœtal pulse rate can be elicited by compressing the head at the fundus between the fingers.

PLATE XIII.



First Maneuver. Second Maneuver.



Third Maneuver. Fourth Maneuver.

PALPATION IN LEFT SACRO-ANTERIOR PRESENTATION.

In doubtful cases, the diagnosis may be facilitated by means of the x-ray, and in such circumstances it will usually be found that the head is less sharply flexed and that the arms occupy a much freer position than is generally taught.

On vaginal or rectal examination the diagnosis of a frank breech presentation is made by recognizing its characteristic portions. Usually one can feel both tubera ischii, the sacrum with its spinous processes, and the anus, and when further descent has occurred the external genitalia may be distinguished. Especially where labor is prolonged, the buttocks may become markedly swollen, so that differentiation between the face and breech may be rendered very difficult, as the anus may be mistaken for the mouth, and the ischial tuberosities for the malar bones. Care in examination, however, should prevent this error, for when the finger is introduced into the anus it experiences a muscular resistance, whereas in the mouth the firmer, more unyielding jaws would be felt. Again, on removing the finger, it is sometimes found to be stained with meconium, which could never occur with a face presentation. The most accurate information, however, is obtained from the sacrum and its spinous processes, for when these are felt the diagnosis of position and variety is established.

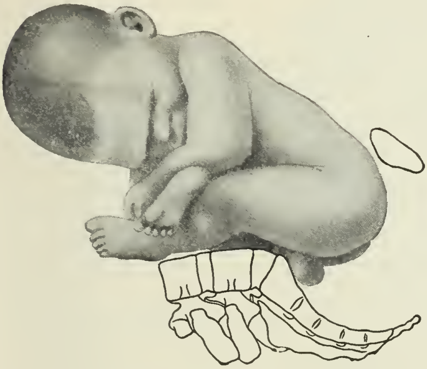


Fig. 305.—Diagram Showing Position of Child in L. S. A.

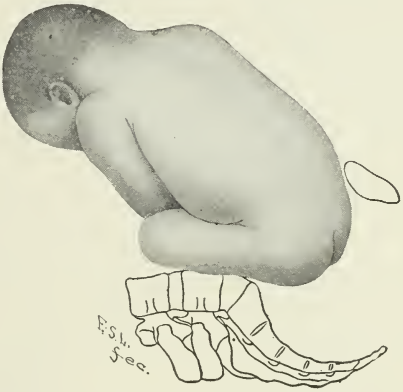


Fig. 306.—Diagram Showing Position of Child in R. S. A.

In complete breech presentations the feet may be felt alongside of the buttocks, and in footling presentations one or both feet may hang down into the vagina. In the latter case, one can readily determine with which foot one has to deal by bearing in mind the relation of the great toe. When the breech has descended deeper into the pelvic cavity, the genitalia may be felt, and if these are not deformed by an effusion of serum it is possible to determine the sex of the fœtus. Only in such circumstances can we feel certain as to this point before delivery.

The fœtal heart sounds are heard through the back of the child, usually at the level of the umbilicus or slightly above it.

Etiology.—The causes of breech presentations are manifold. According to the experiments of Schatz, the fœtus, when suspended in liquor amnii, always sinks by its buttocks, so that, if gravity were the only factor concerned, breech presentations would be the most frequent of all. As a matter of fact, however, this is by no means the case.

In the later months of pregnancy head presentations result from a process of accommodation between the fœtal ovoid and the uterus; accordingly, breech presentations are prone to occur when the process is interfered with. These factors do not so readily come into play in the earlier months, when breech presentations are much more common than at term. They are also frequently lacking in twin pregnancies and in cases of hydramnios, inasmuch as the increased distention of the uterus interferes with accommodation. According to Pinard's statistics, 59 per cent of all breech presentations occur in multiparæ, in whom the flaccidity of the uterine and abdominal walls plays a part in their production. Their occurrence is also favored by the presence of any obstacle which opposes the engagement of the vertex, as contracted pelvis, excessive size of the normal head, or hydrocephalus.

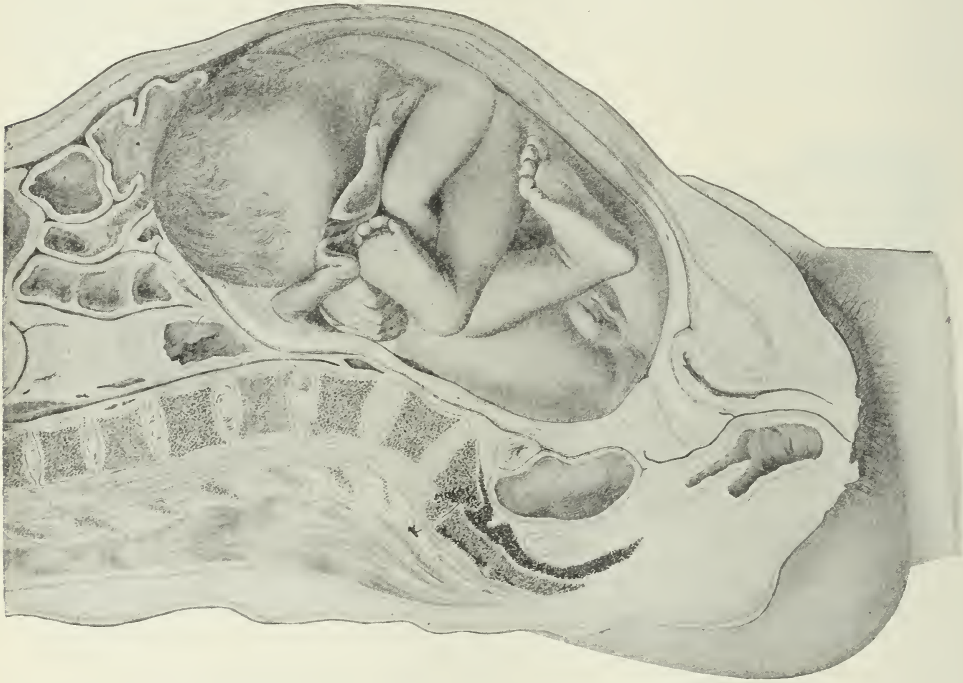


FIG. 307.—FROZEN SECTION, LATTER PART OF PREGNANCY, CHILD IN L. S. T. (Waldeyer).

Mechanism.—Unless there be some disproportion between the size of the child and the pelvis, *engagement* and *descent* readily occur in one of the oblique diameters of the pelvis, the anterior hip being directed toward one iliopectineal eminence, and the posterior hip toward the opposite sacro-iliac synchondrosis. The former usually descends more rapidly than the latter, and, when it encounters the resistance of the pelvic floor, *internal rotation* usually occurs and brings the anterior hip to the pubic arch, the bitrochanteric diameter of the child coming into relation with the anteroposterior diameter of the pelvic outlet. Rotation usually takes place from the iliopectineal eminence to the pubis through an arc of 45 degrees. If, however, the posterior extremity is prolapsed it always rotates to the symphysis pubis, rotation ordinarily occurring through an arc of 135 degrees, but occasionally it will take place in the opposite direction, the prolapsed hip rotating past the sacrum and through the opposite half of the pelvis, through an arc of 225 degrees. Sellheim explains the latter phenomenon by assuming that the retained leg acts as a splint to the corresponding side of the body, with the result that it cannot so readily undergo the lateral flexion necessary to delivery as the side which is not so splinted.

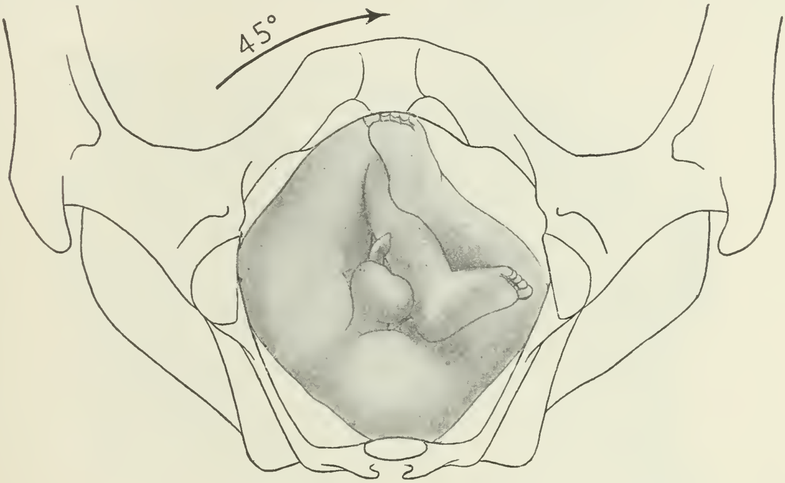


Fig. 308.—Diagram Showing Direction of Internal Rotation in R. S. P. Position.

After rotation, descent continues until the perineum is distended by the advancing breech, while the anterior hip appears at the vulva and is stemmed against the pubic arch. By a movement of *lateral flexion* of the body, the posterior hip is then forced over the anterior margin of the perineum, which retracts over the child, thus allowing its body to straighten out, when the anterior hip is born. The legs and feet follow the breech and may be born spontaneously, although the aid of the obstetrician is sometimes required. After the birth of the breech a slight movement of *external rotation* occurs, and the back usually turns somewhat to the front, as the result of the shoulders being brought into relation with one of the oblique diameters of the pelvis. They then descend rapidly and undergo internal rotation, the bisacromial diameter now corresponding with the anteroposterior diameter of the inferior strait. Immediately following the shoulders, the head, which is normally sharply flexed upon the thorax, enters the pelvis in one of the oblique diameters, and then rotates in such a manner as to bring the posterior portion of the neck under the symphysis pubis, after which the head is born in a position of flexion, the chin, mouth, nose, forehead, bregma, and occiput appearing in succession over the perineum (Figs. 309 and 310).

Le Lorier has aptly directed attention to the fundamental difference between birth in vertex and breech presentations, respectively. In the former, after the extrusion of the voluminous head the rest of the body follows without difficulty; whereas, in the latter successively larger portions of the child are born, so that for practical purposes we have to deal with three births—that of the buttocks, of the shoulders, and finally of the head, each of which is preceded by a separate movement of internal rotation.

In a small number of cases rotation occurs in such a manner that the back of the child is directed toward the vertebral column, instead of toward the abdomen of the mother. In such circumstances the face appears under the symphysis pubis, the face, brow, and finally the occiput slipping down under it, as the head is born. It is of the utmost importance to remember that if premature traction be employed the head may become extended, when its delivery can only be accomplished by the operation of extraction.

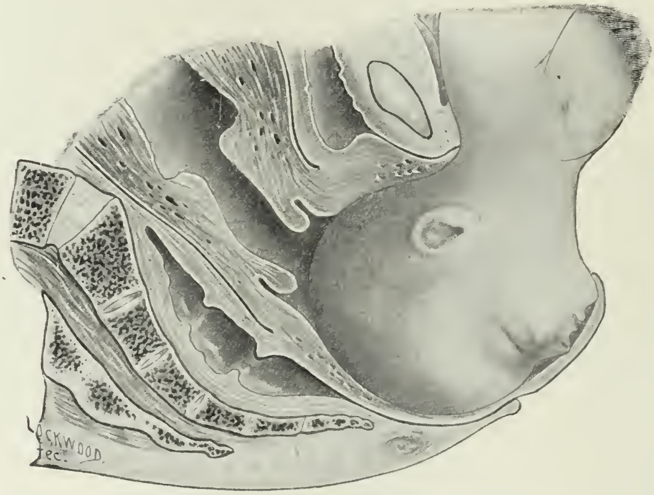


Fig. 309.—Birth of Head in Breech Presentation.

Prognosis.—So far as the life of the mother is concerned, the prognosis differs but slightly in breech and vertex presentations, except that with the former labor is slower, and in operative cases is more liable to be complicated by perineal tears, which sometimes extend through the sphincter ani muscle. The prognosis for the child, on the other hand, is considerably worse, particularly so in the case of frank breech presentations in primiparous women. The fœtal mortality varies between 10 and 14 per cent (Irving and Goethals, and Martius), and is naturally higher in primiparous than in multiparous women.

The somber prognosis for the child is due to several factors. In the first place, after the breech is born as far as the umbilicus, the cord is exposed to a greater or lesser degree of compression between the head and the pelvic brim. It is usually stated that not more than eight minutes can elapse between the birth of the umbilicus and the delivery of the head, if the child is to be born alive. This is not quite correct, as a much longer time may elapse, provided the mouth has appeared at the vulva and thereby affords the possibility for the establishment of pulmonary respiration. Occasionally fœtal death is due to the premature separation of the placenta, for, if the delivery is not promptly effected after the head has passed into the lower part of the birth canal, the partially emptied uterus may retract to such an extent as to separate the placenta from its walls, and thus put a stop to the uteroplacental circulation.

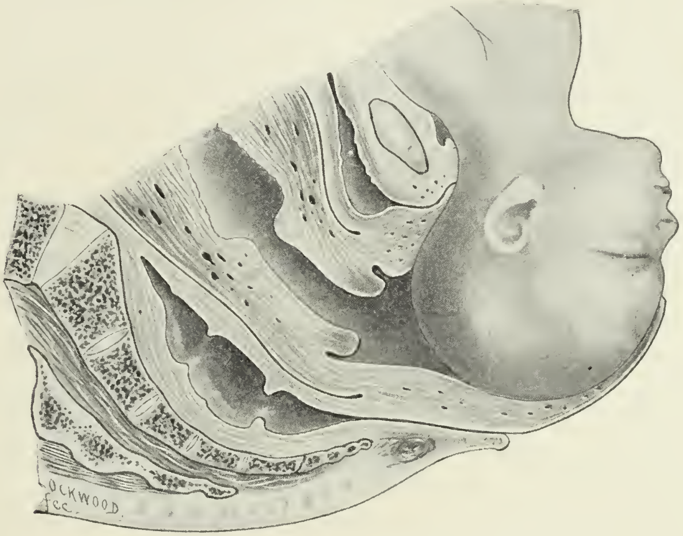


Fig. 310.—Birth of Head in Breech Presentation.

Holland, and Capon, in 1922, established the predominant cause of fœtal death in breech presentations, by showing that the probability of the occurrence of tentorial tears and subsequent intracranial hemorrhage is twice as great as in head presentations; while Crothers and Putnam have emphasized the part played by lesions of the spinal cord. The first mentioned authors have also shown when extraction is practiced, and especially when it is aided by suprapubic pressure upon the head, that the medulla may protrude through the foramen magnum and actually become herniated into the spinal canal. It should also be remembered, when premature attempts at extraction are made, that descent of the head may be interfered with by the imperfectly dilated cervix, when great force may be required to overcome the resistance.

In primiparous women, where considerable resistance is offered by the pelvic soft parts, spontaneous delivery of the head is often unavoidably delayed and fœtal death results, unless the child be extracted manually.

Treatment.—In view of the serious fœtal prognosis attending breech presentations, the obstetrician should aim to prevent their occurrence as far as possible, and whenever they are recognized in the later weeks of pregnancy an attempt should be made to substitute a vertex presentation by means of *external version,* unless there exists such disproportion between the size of the head and the pelvis as to make the occurrence of spontaneous delivery dubious. This procedure is devoid of danger, and has given such excellent results in my hands that I cannot comprehend the attitude of those who oppose it. External version is readily accomplished in multiparæ with lax abdominal walls, but is more difficult in primiparæ. If the head can be forced into the pelvis after the substitution has been effected, the new position becomes permanent; but if this is not possible, the child will usually revert to its original position, notwithstanding the application of a properly fitting bandage. In the former case, the result affords striking proof of the value of routine antepartum examination. External version may also be attempted in the first stage of labor, provided the breech has not descended deeply into the pelvis; but when it has once become fixed, all such efforts are unavailing.

In most breech presentations spontaneous delivery occurs, and the attitude of the obstetrician should be merely one of expectancy; nevertheless, he should always hold himself in readiness to intervene at a moment's notice. For this reason, as soon as the breech appears at the vulva, the patient should be brought to the edge of the bed in order that not a moment may be lost in performing extraction should it become necessary. The breech should be allowed to advance spontaneously until the umbilicus has been born, and even then extraction should not be considered unless it appears probable that more than eight minutes will elapse before the completion of delivery. It is most important to remember that the completion of labor is materially facilitated by the arms retaining their normal crossed position over the thorax, as well as by sharp flexion of the head. This is best attained by avoiding traction as far as possible and by moderate downward pressure upon the fundus as soon as the breech begins to emerge through the vulva, which should be maintained by the nurse or an assistant, so that the obstetrician can keep his hands clean for any emergency. Owing to the fact that the breech forms a less efficient dilating wedge than the head, care should be taken to prevent premature rupture of the membranes and the escape of the amniotic fluid.

Generally speaking, the frank breech forms a better dilating wedge than the complete breech, inasmuch as it allows a closer application to the margins of the partially dilated os. On the other hand, if interference becomes necessary, the complete breech offers more satisfactory conditions for immediate delivery, as a foot can readily be brought down and used as a tractor, so that the question arises whether it might not be better in the former class of cases to make it a rule to bring down one or both feet prophylactically. Usually this is not advisable, unless some abnormality exists on the part of the mother or child which renders it probable that prompt delivery may be called for. In such cases as soon as the cervix is practically fully dilated, the membranes should be ruptured and both feet brought down into the vagina so that extraction can be promptly effected when necessary. The technic of this manipulation, as well as the rules for extraction, will be considered in Chapter XXI. In recent years, in the conduct of breech presentations in primiparæ, I have adopted with great satisfaction the advice of Vignes to introduce into the vagina a large size rubber balloon as soon as the cervix is 4 or 5 centimeters in diameter. This serves the double purpose of preventing premature rupture of the membranes, and of bringing about such dilatation of the vaginal canal and vulval outlet that no obstacle is opposed to the passage of the head, no matter whether it occurs spontaneously or is effected by extraction.

In view of the serious fœtal mortality, many writers recommend a more radical policy, and Irving and Goethals advocate bringing down the feet as soon as the cervix has become fully dilated and eliminating the second stage by prompt extraction. Piper, on the other hand, holds that many children are lost as the result of extraction, and advocates in its stead the application of forceps to the after-coming head. I have had no experience with either method, and their advantages must be considered as still *sub judice.*

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CHAPTER XIV

PHYSIOLOGY AND MANAGEMENT OF THE THIRD STAGE OF LABOR

Situation of the Placenta in Utero.—The older authors believed that the placenta was usually implanted at or in the immediate neighborhood of the fundus. The researches of Schroeder, Pinard, Ahlfeld, Leopold, Holzapfel, and others, however, have shown that this is by no means the rule, but that the most common situation is on the anterior or posterior wall of the uterus, occasionally on its lateral wall, and only in exceptional instances upon the fundus. Figure 311 shows the usual mode of attachment. As a rule, the lower margin of the placenta lies well above the internal os, because when it impinges

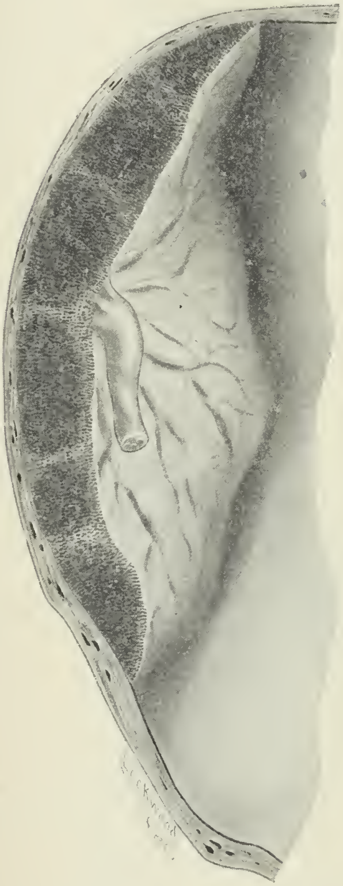


FIG. 311.—DIAGRAM SHOWING RELATION OF PLACENTA TO UTERINE WALL IN LATTER PART OF PREGNANCY. × ½.

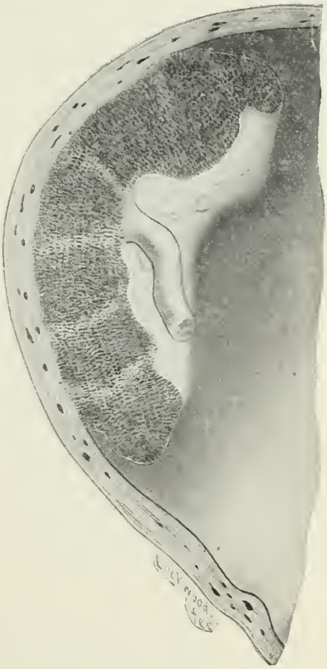


FIG. 312.—DIAGRAM SHOWING RELATION OF PLACENTA TO UTERINE WALL IN SECOND STAGE OF LABOR (modified from Schroeder). × ½.

upon or overlaps it we have to deal with a pathological condition—placenta prævia.

Mechanism of Separation of the Placenta.—Under normal conditions the placenta remains fixed to the uterine wall until after the birth of the child, and becomes separated from it only during the third stage. During labor the uterine contractions bring about a slight decrease in the area of placental attachment, and in its attempt at accommodation the placenta becomes thicker and its margins more rounded and prominent. At the same time it is pressed firmly against the uterine wall by the intra-uterine pressure; otherwise it is probable that premature separation would be the rule and not the exception.

As the child is being expelled from the uterus, its cavity becomes progressively smaller to correspond to the decreasing bulk of its contents, so that when the child is born, the uterine cavity has become obliterated and the organ is represented by an almost solid mass of muscle, whose fundus lies several centimeters below the umbilicus. A vertical section through the uterus at this time (Fig. 313), shows that as the result of contraction and retraction its walls have become several centimeters thick and are closely applied to the placenta, which is still attached, but, owing to the diminution in its area of attachment, has become approximately twice as thick as at the onset of labor.

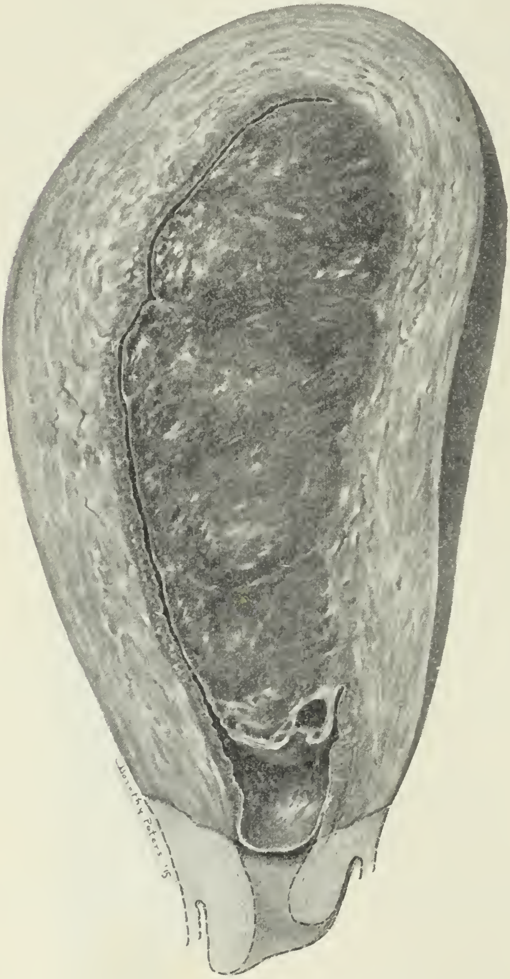


Fig. 313.—Vertical Section through Uterus Removed by Supravaginal Hysterectomy Following Cesarean Section. × ⅔. (Note thickness of muscle walls, increase in thickness of placenta, and decrease in area of its attachment.)

As a result of the great decrease in the superficies of the rest of the interior of the uterus, the fœtal membranes and the decidua vera are obliged to accommodate themselves to the changed conditions, and, as they are not contractile or elastic, they are thrown into innumerable small festoons or folds, so that

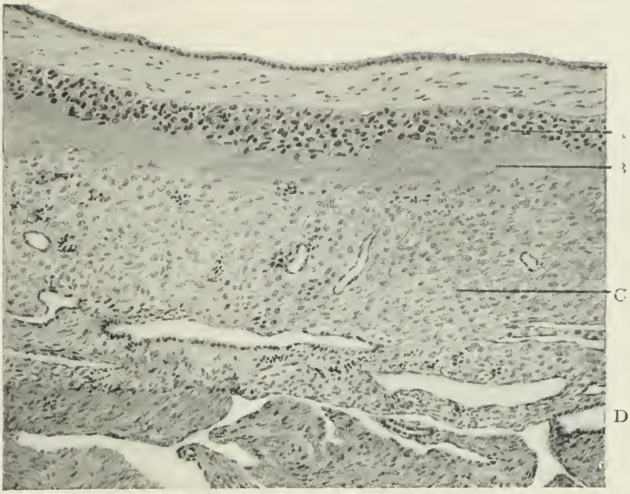


FIG. 314.—SECTION THROUGH WALL OF PREGNANT UTERUS OUTSIDE OF PLACENTAL SITE. × 66. (For comparison with Fig. 316.)

A, amnion and chorion læve; *B,* fibrin layer; *C,* decidua vera; *D,* muscularis.

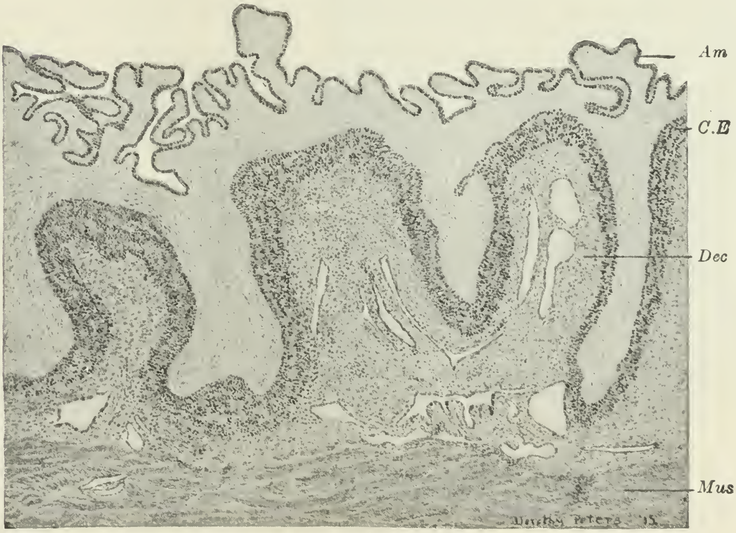


FIG. 315.—SECTION THROUGH UTERINE WALL OUTSIDE OF PLACENTAL SITE DURING THIRD STAGE, SHOWING FESTOONING OF MEMBRANES. × 25.

Am., amnion; *C.E.,* epithelium of chorion; *Dec.,* decidua vera; *Mus.,* muscularis.

the layer increases from a fraction of a millimeter to 3 or 4 millimeters in thickness.

Figures 314 and 316, which represent the lining membrane of the uterus at the end of pregnancy and early in the third stage, respectively, give a good idea of the condition of affairs, and make it apparent that a very considerable proportion of the decidua vera has become included between the folds of the festooned amnion and chorion læve.

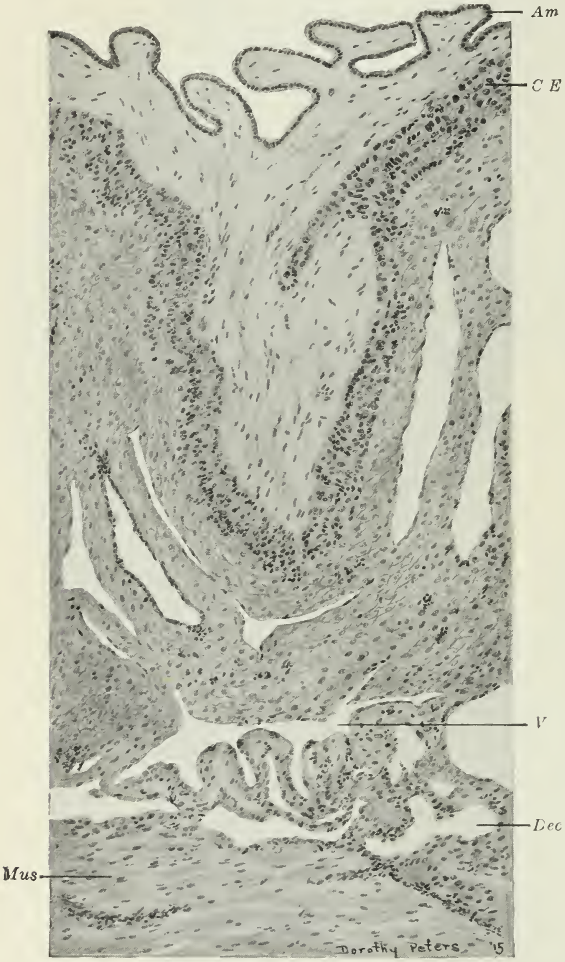


Fig. 316.—Portion of Fig. 315 More Highly Magnified. × 66.

Am., amnion; *C.E.*, epithelium of chorion læve; *Dec.*, decidua vera, gland spaces; *Mus.*, muscularis; *V.*, vascular spaces in decidua.

As the uterus continues to contract and retract, its muscular walls become thicker and thicker, and the area of the placental attachment smaller and smaller, so that eventually a period is reached when the comparatively compact placenta can no longer follow this change, and consequently is peeled off from the uterine wall and lies free in the cavity, whence it is expelled into the collapsed and flabby lower uterine segment by further contractions. The separation takes place in the spongy layer of the decidua basalis, so that a portion is cast off with the placenta, while the balance remains attached to the muscularis (Fig. 317). The process of detachment is inaugurated by lesions of continuity in the decidua, and is accelerated by the effusion of blood into the spaces thus formed. Frankl, on the contrary, thinks that the decrease in area has little to do with the process, but holds that detachment is inaugurated by the rupture of vessels in the decidual septa, which results from their sudden engorgement incident to the decrease in intra-uterine pressure following the birth of the child.

The amount of decidual tissue which is retained at the placental site is dependent upon the original thickness of the decidua basalis, and varies within wide limits, as is well shown by Figures 318 and 319, which represent the conditions in two normal uteri, which were amputated at cesarean section just after the extrusion of the placenta.

The membranes usually remain in situ until the separation of the placenta is practically completed, and are then peeled off from the uterine wall partly by the further contraction and retraction of the muscularis, and partly by traction exerted by the separated placenta, which now lies in the flabby lower uterine segment or the upper portion of the vagina. At this time the body of the uterus has become converted into an almost solid mass of muscle, whose anterior and posterior walls each measure 4 to 5 centimeters in thickness and lie in such close apposition that the uterine cavity is practically obliterated.

Reference to Figure 315 makes it clear that the greater portion of the decidua vera has been included between the festooned folds of the amnion and chorion læve, and must be cast off when separation occurs. Consequently the portion which remains attached to the uterine wall is relatively thin, and, were it not for the great decrease in the size of the uterine cavity, it would represent only a fraction of the thickness noted during the last days of pregnancy.

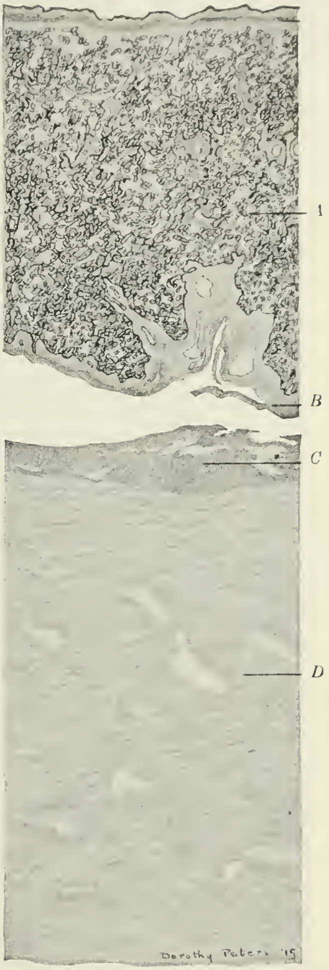


Fig. 317.—Diagram Showing Separation of Placenta, and Approximate Amount of Decidua Basalis Usually Cast Off with it, and Retained in Utero. × 3.

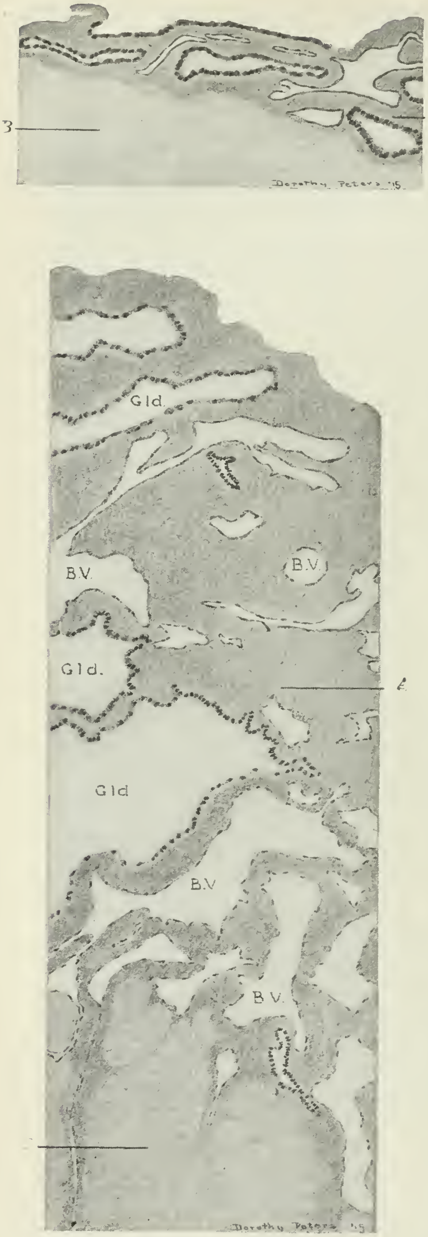
A, placenta; *B*, *C*, decidua basalis; *D*, muscularis.

Mode of Extrusion of the Placenta.—As early as 1789, Baudelocque had described two ways in which the placenta could be extruded from the uterus. Thus, separation from the uterine wall could commence either at the center of the placenta or at a point in its circumference. "In the first case the middle of the placenta being pushed forward by an effusion of blood beneath it, the organ becomes inverted upon itself in such a manner that it presents by its fœtal surface, which is covered by the membranes and vessels. . . . But when the placenta becomes detached below, particularly if the loosening begins at a point in the neighborhood of the internal os, the mechanism is entirely different, for the after-birth becomes rolled upon itself in the form of a cylinder, whose long axis corresponds to that of the uterus, in such a manner that it presents its detached maternal surface to the examining finger, and its exit is always preceded by a small amount of fluid blood."

These ideas seem to have excited but little interest until 1865, when Schultze advanced the opinion that the placenta was usually expelled by the first method described by Baudelocque. This belief remained practically undisputed until 1871, when Matthews Duncan contended that the second was the more frequent and therefore the normal mechanism. The active discussion aroused by this controversy had the effect of directing more earnest attention to the physiology of this stage of labor.

The two methods are now designated by the names of Schultze and Duncan, respectively. In the former separation begins first at the central portion of the placenta, between which and the uterine wall more or less blood is poured out, which gradually increases in amount until a retroplacental hematoma of considerable size is formed, which eventually brings about the complete separation of the organ from its site of attachment, while the membranes still remain adherent. The placenta then presents at the internal os by its fœtal surface and, passing through the opening in the membranes, drags them after it; it is then expelled from the vulva, its fœtal or amniotic surface first, and the now inverted membranes following after. In this mechanism there is no escape of blood until after the extrusion of the placenta has taken place (Figs. 320 and 321).

In Duncan's method, on the other hand, the placenta, after its separation from the uterine wall, becomes folded upon itself and its lower margin presents at the internal os. It then traverses the vagina and emerges from the vulva by one margin, the membranes being sometimes, but by no



FIGS. 318 and 319.—DIAGRAMS OF PLACENTAL SITE SHOWING RETENTION OF MINIMAL AND EXCESSIVE AMOUNTS OF THE SPONGY LAYER OF THE DECIDUA BASALIS.

A, decidua basalis; *B*, muscularis; *B.V.*, blood vessel; *Gld.*, glandular spaces.

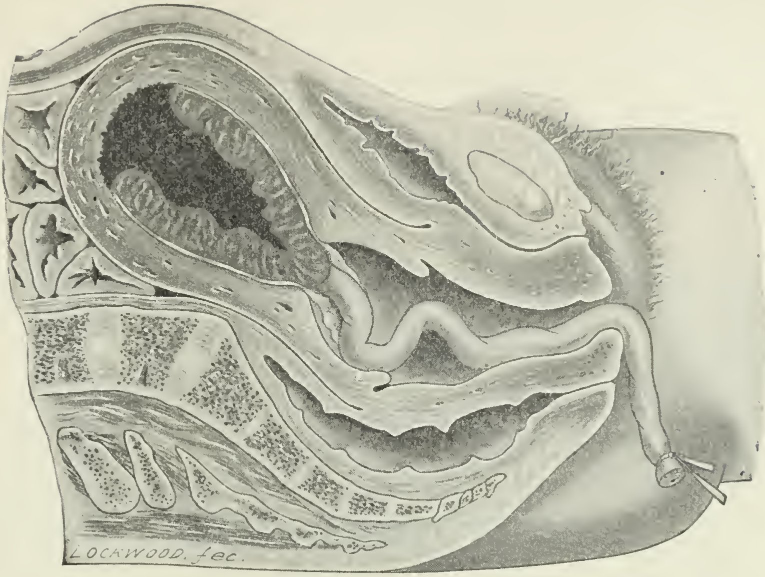

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FIG. 320.—DIAGRAM ILLUSTRATING EXTRUSION OF PLACENTA BY SCHULTZE'S MECHANISM

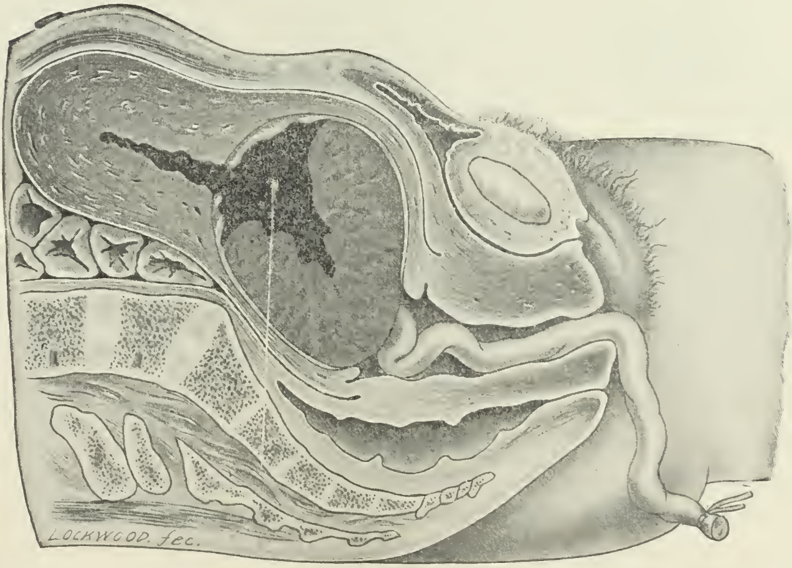
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FIG. 321.—DIAGRAM ILLUSTRATING LATER STAGE IN THE EXTRUSION OF THE PLACENTA BY SCHULTZE'S MECHANISM.

means always, inverted. When expulsion occurs in this manner, there is slight but continuous hemorrhage from the birth of the child until the placenta is delivered (Fig. 322).

With respect to the relative frequency with which these two mechanisms occur there has been much discussion. In this country and in England Duncan's views are commonly accepted, while in Germany the contrary view is generally held. Holzapfel, in an excellent monograph, has given details and a full literature dealing with the status of the question up to 1899. Certainty in this respect was attained by means of the interesting observations of Weibel, and Warnekros, who immediately after the birth of the child cut the cord, and, through its vessels, injected the placenta with a substance which would cast a shadow under the x-ray. Röntgenograms made immediately thereafter showed three things—first, that in two-thirds of the cases separation occurred with the first or second postpartum contraction; second, that the placenta always passed through the contraction ring by its margin, and that the formation of a retroplacental hematoma played very little part in bringing about its separation; and third, that the mechanisms described by Duncan and Schultze developed only in the vagina and consequently applied only as the placenta emerged from the vaginal outlet. For this reason they contend that differentiation between the two methods is a matter of indifference, as the placenta always leaves the uterus in one way.

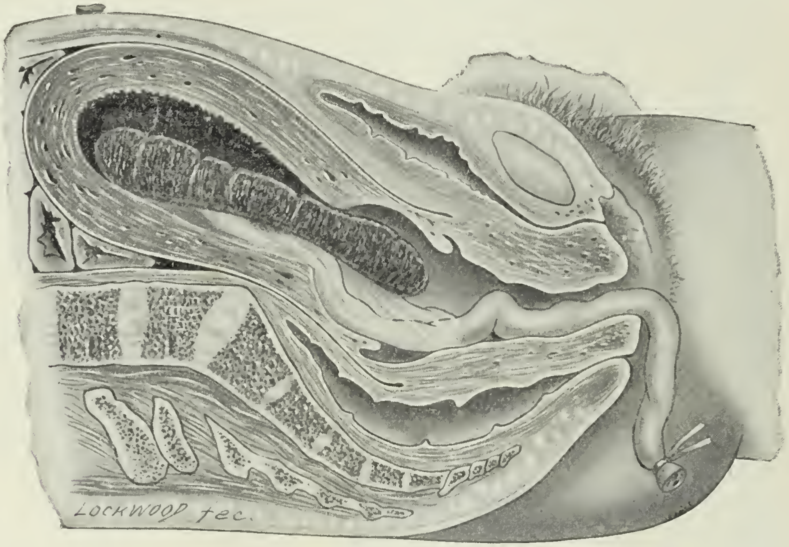

Fig. 322.—Diagram Illustrating Extrusion of Placenta by Duncan's Mechanism.

My experience is that the placenta usually escapes from the vulva by the Schultze mechanism, and similar views are held by Tucker and Freeland. The former, in 2700 labors occurring at the Sloane Hospital, noted Schultze's mechanism in 64.8 per cent of the cases, as compared with 82.5 per cent observed by the latter in 2600 labors at the Rotunda Hospital, Dublin. Freeland believes that a more frequent occurrence of Duncan's mechanism is due to the fact that the uterus had been kneaded during the third stage, and his belief is confirmed by the fact that in Tucker's series expression by Credé's method was routinely employed. In other words, the evidence available indicates that the placenta usually escapes from the uterus by the mechanism of Duncan, and emerges from the vulva by that of Schultze.

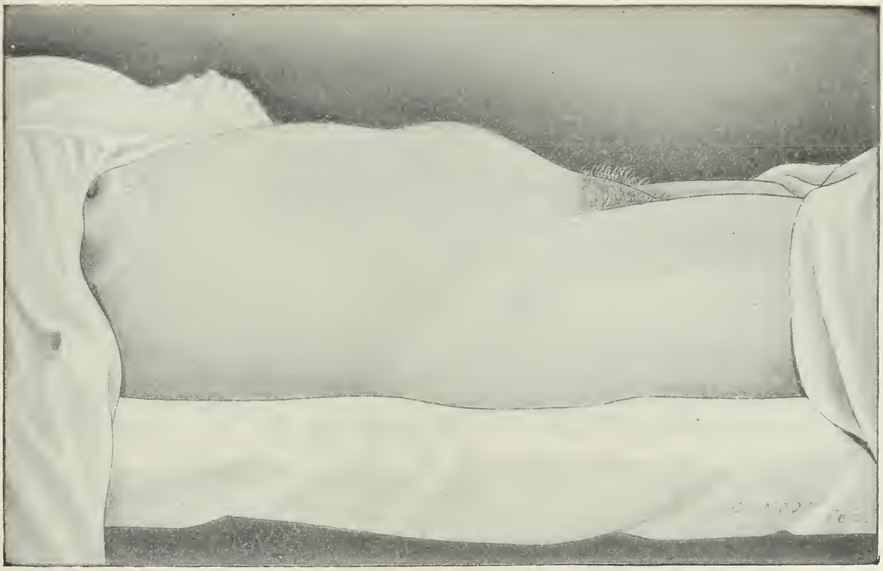

Fig. 323.—Abdomen Immediately after Birth of Child.

Clinical Picture of the Third Stage of Labor.—Immediately following the birth of the child the remainder of the amniotic fluid escapes, after which there is usually a slight flow of blood. The uterus can now be felt as a firm, hard mass, the fundus lying well below the umbilicus. For a short time the patient experiences no pain, but after a few minutes uterine contractions begin again and recur at regular intervals, until the placenta becomes separated and is expelled into the lower uterine segment.

At some time, varying between five and thirty minutes after the birth of the child, palpation shows that the fundus of the uterus has risen up to or above the umbilicus, or three to seven centimeters above its original position, while simultaneously a slight prominence has appeared immediately above the symphysis pubis (Figs. 323 and 324). At the same time the portion of umbilical cord protruding from the vulva has increased by 10 or 12 centimeters in length. These changes indicate that the placenta has been extruded from the uterine cavity proper into the lower uterine segment, or even into the upper part of the vagina. The rising of the fundus is due to the fact that the lower uterine segment, which immediately after the birth of the child had collapsed upon itself, is now distended by the placenta, and mechanically lifts the tightly contracted body of the uterus to a higher level. In rare cases the placenta is born almost immediately after the child, in about one quarter of the cases it is delivered spontaneously fifteen to thirty minutes later, while occasionally hours may pass before it appears at the vulva. The possibility of wide divergence in this respect can readily be appreciated when we remember that the action of the uterus ceases after the placenta has been extruded from its cavity, so that its further descent depends upon the contraction of the abdominal muscles, or upon the action of gravity. But owing to the great distention to which they have been subjected, the tonicity of the abdominal muscles is frequently so impaired that they can no longer exert sufficient force to expel the after-birth from the vagina, so that in many cases it will not be born for hours unless the patient assumes a sitting position or assistance is rendered by the physician. Ahlfeld has stated that spontaneous termination of the placental period occurred in only 13.6 per cent of his cases, even when he waited for one to two hours after the birth of the child.

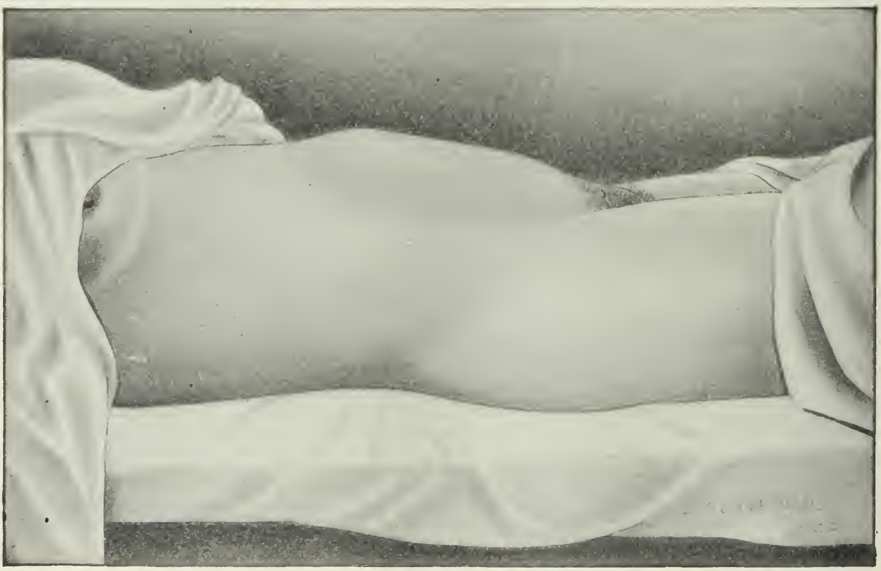

FIG. 324.—ABDOMEN OF SAME PATIENT, SHOWING RISING UP OF FUNDUS FOLLOWING EXTRUSION OF THE PLACENTA INTO THE LOWER UTERINE SEGMENT.

The average loss of blood during the third stage of labor is less than 500 cubic centimeters, a constant but slight flow occurring throughout the entire period when the placenta is delivered by Duncan's mechanism, and a sudden gush of blood immediately following its expulsion by Schultze's mechanism.

In 1000 consecutive spontaneous labors I found that the average loss was 343 cubic centimeters, with extremes of 0 and 2400 cubic centimeters. Indeed, even this average gives an exaggerated idea of what may be expected in the individual patient, for upon arranging my patients in groups according to the number of 100 cubic centimeters of blood loss, it was found that groups 100 to 199 and 200 to 299 were much larger than any others. In other words, the amount of blood most commonly lost varies between 100 and 300 cubic centimeters, or somewhat less than the average. A loss exceeding 600 cubic centimeters should be considered abnormal, although postpartum hemorrhage rarely exposes the patient to serious danger unless it exceeds 1500 cubic centimeters. Ahlfeld holds that the amount lost increases with the size of the child and with that of the placenta. Moreover, he contends that it is more profuse when the placental period is of short duration, and is least when it lasts for one and a half or two hours, but this is contrary to my experience.

Management of the Third Stage of Labor.—Up to 1861 the management of the third stage of labor varied greatly, and delivery of the placenta was effected either by traction upon the cord or by passing the hand into the vagina or uterus, as the case might be, and bringing it away. Both of these methods, but more particularly the latter, as will be explained later, are necessarily attended by grave dangers.

In 1853, Credé described what he considered the ideal method of delivering the placenta, which was somewhat as follows: Immediately after the exit of the child the obstetrician grasps the uterus with his hand and, after waiting from five to ten minutes, gently kneads it, thereby stimulating it to contract and to separate the placenta. The hand is then applied to the abdomen in such a manner that the thumb rests upon the anterior and the fingers upon the posterior surface of the uterus, and as soon as a contraction occurs, firm and steady pressure should be made downward in the axis of the superior strait.

The introduction and routine employment of Credé's method, which aimed at hastening the separation of the placenta and then expressing it from the uterine cavity, undoubtedly marked a most important advance, inasmuch as, by doing away with the necessity for traction upon the cord and the frequent manual removal of the placenta, it has saved the lives of thousands of women. With certain modifications it is now generally employed throughout the world. As a matter of history, Jellett has noted that the method, while usually ascribed to Credé, had been practiced a century previously at the Rotunda Hospital in Dublin, and appears to have originated with John Harvie, in 1767.

In opposition to the expression of the placenta immediately after the birth of the child, Dohrn, Ahlfeld, and others have stated that a greater amount of blood is lost during the third stage, and that there is a greater tendency to postpartum hemorrhage, due to imperfect separation, than when the extrusion of the placenta is left to nature, or when expression is resorted to only after an interval of several hours. But, while it is recognized as incontrovertible that too early a resort to Credé's method is harmful, inasmuch as it defeats the very purpose for which it is employed and interferes with the physiological separation of the placenta, the arguments adduced in favor of waiting so long a time appear to be neither satisfactory nor rational. It is difficult to see what advantages are to be gained by delaying expression after the placenta has once become detached from its original site and lies in the lower uterine segment, more particularly as Ahlfeld claims that spontaneous delivery will occur in less than 14 per cent of the patients at the end of two hours. Furthermore, there are certainly very obvious objections to any unnecessary prolongation of the third stage of labor. For the patient such a delay means additional discomfort, while the busy physician can ill afford the expenditure of valuable time, unless he be convinced that by such personal sacrifice he can better insure the well-being of his patient.

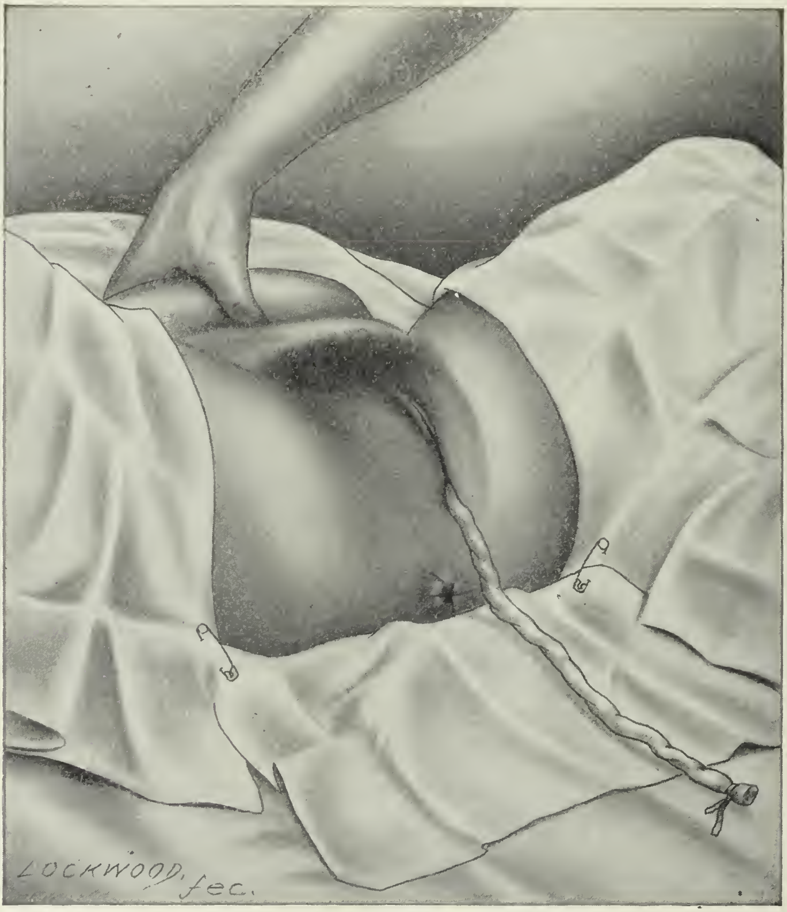

Fig. 325.—Expression of Placenta.

In normal cases, therefore, attempts at expression should not be made until the placenta has been spontaneously expelled into the lower uterine segment or upper portion of the vagina, as is indicated by the rising up of the fundus; but as soon as this has taken place there is no reason why the process should not be hastened. In my own clinic the following procedure has been adopted with satisfactory results: As soon as the child is born the hand is laid upon the abdomen, and if the uterus be felt as a firm, hard, globular mass it is left absolutely alone. On the other hand, if it appears to be soft and flaccid, it is gently kneaded until firm contractions are induced. The condition of the uterus is then carefully watched by applying the hand to it every few minutes, but kneading it only when necessary. In the majority of cases, after a lapse of ten or fifteen minutes, it is noticed that the fundus rises spontaneously several centimeters above the position which it had just occupied, and at the same time remains firm and hard. This change indicates that the placenta has become separated from the uterine wall and is distending the lower uterine segment or the upper portion of the vagina. The placenta is now expelled by grasping the uterus and making downward pressure in the axis of the superior strait, using the uterus merely as a piston to shove the placenta through the vagina. When the latter appears at the vulva it should be grasped by the hand and the membranes gently twisted into a cord, so as to prevent their being torn off from the margins of the placenta, after which they are slowly extracted. In doubtful cases important information may sometimes be obtained by holding the cord lightly between two fingers and making firm pressure upon the uterus with the other hand. If the placenta is still adherent, a distinct wave will be felt in the cord, which will be absent if separation has already occurred. Attention was first directed to the significance of the rising of the fundus by Pinard, Schroeder, and Cohn, but its importance has not been generally recognized.

The modification here recommended, which we designate as "expression from the vagina," leaves the separation of the placenta from the uterine wall entirely to nature, and simply expresses it after it has been spontaneously expelled from the uterine cavity, and should not be confounded with the original Credé method, whose object is to hasten separation and then to express the placenta from the uterine cavity. In most cases the placenta can be expressed from the vagina within half an hour after the birth of the child; but if the fundus does not rise up spontaneously by the end of that period, it is my practice to attempt to hasten separation by resort to the typical Credé method of expression.

Frequently small portions of the membranes may be left behind *in utero* or in the vagina. If the ends be outside the vulva, they should be seized with an artery clamp and the remnants delivered by gentle traction; but otherwise it is advisable to leave them alone and to allow them to be cast off with the lochia, rather than to introduce the fingers into the vagina or uterus in the attempt to remove them. Immediately after the extrusion of the after-birth, and before laying it down the obstetrician should turn back the membranes and carefully inspect the maternal surface of the placenta for the purpose of ascertaining whether it is intact, or whether portions have been left behind in the uterus. If the maternal surface is perfectly intact, all is well; but if it shows defects which are not due to mere tears of its substance, or if vessels extend from its margin to a defect in the membranes, it means that a portion of a cotyledon or a succenturiate lobule has been retained. In such circumstances the vulva should be again disinfected, fresh gloves put on, and the retained portion removed manually, since if allowed to remain in the uterus it will almost certainly give rise to postpartum or puerperal hemorrhage. I lay particular stress upon the necessity for the routine inspection of the placenta, as to its neglect many serious accidents, or even the death of the patient, may be attributed.

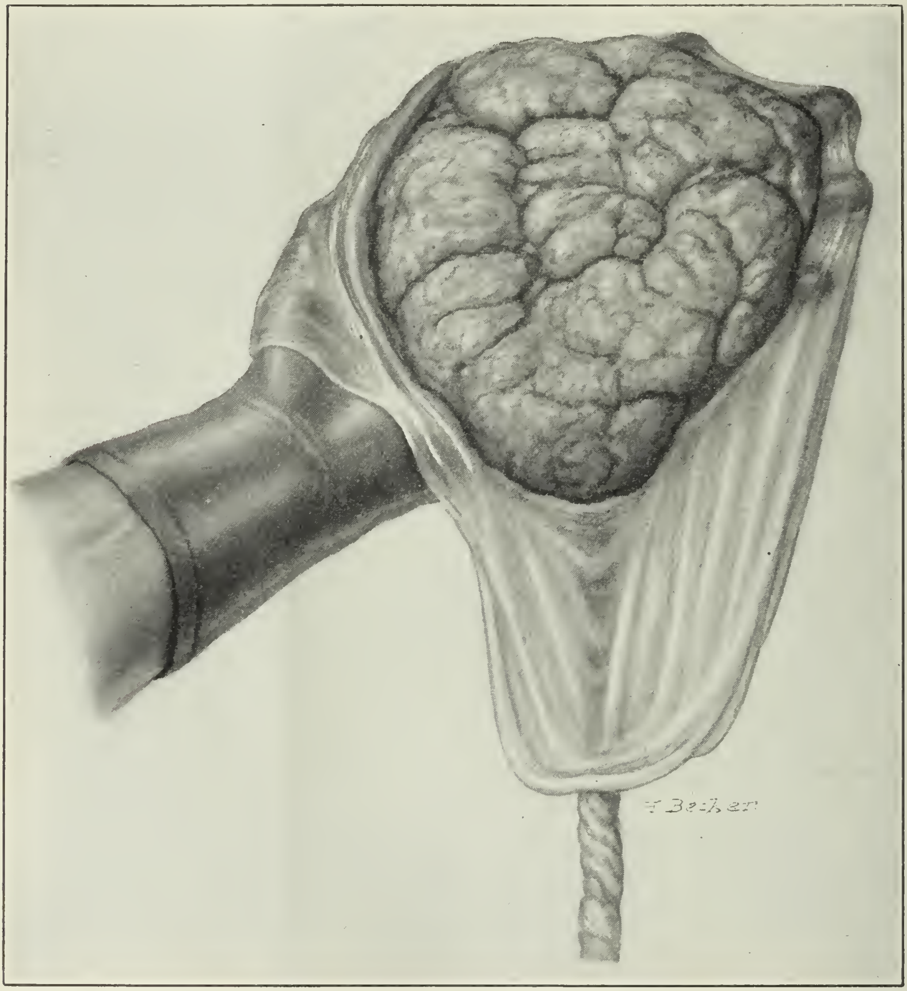

Fig. 326.—Inspection of Placenta Immediately After Its Delivery.

Immediately following the birth of the placenta the uterus should be again palpated; normally it will be found firmly contracted and retracted, and (if it remains so) there is no danger of hemorrhage. But, on the other hand, if it shows any tendency toward relaxation, it should be kneaded until it contracts, and the hand kept constantly upon it, so that beginning relaxation may be detected and combated. There is usually no danger of relaxation and consequent hemorrhage, provided no signs of it appear during the first hour after the extrusion of the placenta. Accordingly, the condition of the uterus should be carefully watched during that period by the physician or nurse. But, even when this duty is delegated to the latter, the physician should remain within reach of the patient for one hour, so as to be on hand in case an emergency should arise. In normal cases, there is no objection to administering one cubic centimeter of pituitary extract hypodermatically, as a prophylactic measure, immediately after the extrusion of the placenta. While it is not necessary, the prompt and vigorous contractions which it induces add somewhat to the peace of mind of the physician and can do no harm. On the other hand, the drug should not be employed so long as the placenta remains in situ, for fear that it may give rise to an hour-glass contraction of the uterus and thereby unnecessarily prolong the third stage of labor.

Occasionally, the amount of blood lost immediately following the birth of the child may be so great as to render imperative the prompt delivery of the placenta, and under such circumstances Credé's method of expression should be employed at once. Under all other conditions, however, we should watch for the rising up of the fundus before resorting to any form of expression.

In rare cases spontaneous separation does not occur, and it may be found impossible at the end of half an hour to expel the placenta by means of Credé's method. In such circumstances, unless the condition of the patient be serious, or there be free hemorrhage, the obstetrician should wait patiently and repeat his attempts at expression at intervals, and should not despair of eventual success until at least one hour has elapsed. In case of failure, it is probable that abnormal adhesions exist between the placenta and the uterine wall, but, in any case, manual removal of the organ must never be undertaken unless this course seems absolutely necessary, as it is a more serious procedure than most obstetrical operations. In the former instance, the hand is introduced between the placenta and the uterine wall, and comes in direct contact with the freshly thrombosed vessels at the placental site, which afford a most excellent culture medium for bacteria; whereas in the latter the hands or instruments are introduced into the amniotic cavity, so that whatever micro-organisms may have been carried up by them are likely to be cast off with the after-birth.

For particulars concerning the control of excessive hemorrhage or the technic of manual removal of the placenta, the reader is referred to the sections on hemorrhage and on obstetrical operations, respectively.

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CHAPTER XV

CONDUCT OF NORMAL LABOR

The services of the obstetrician should be engaged as long as possible before the expected date of confinement, in order that the patient may have the advantages of medical supervision during at least the second half of pregnancy.

The importance of prenatal care, and especially of a careful *preliminary examination,* not later than four to six weeks before term, has already been insisted upon. This should preferably be carried out in the doctor's office with the patient upon a suitable examining table, with sufficient clothing removed to give free access to all parts of the body. After making a thorough general physical examination, the obstetrician should take careful measurements of the pelvis, determine the presentation and position of the child, and acquaint himself with any abnormality which may exist in the generative tract. At the time of this examination, if the patient is to be delivered at home, it is well to give her a list of such articles as may be needed at the time of labor, and which she is expected to supply. The physician should also communicate with the nurse in order to make sure that she understands the preparations which fall to her share. Experience has taught me that the only way by which mistakes can be avoided is by the use of printed cards containing definite and concise instructions for both the patient and nurse.

Preparations for Labor on the Part of the Patient and Nurse.—If the patient is to be delivered at home, the room, to be used for the confinement, should be inspected in advance and suggestions made as to its arrangement. The obstetrician should also inquire as to the number of wash-basins which are available; for with the increasing perfection of plumbing the portable wash-basin has become replaced by permanent washstands, so that in many modern homes it is difficult to find a sufficient number for disinfecting the hands and cleansing the patient. Four basins will be needed: three for the use of the physician and one for the nurse; and if so many are not already in the house, a sufficient number, made of plain agateware and measuring 10 inches across the top, should be procured.

The patient should also be instructed to provide herself with a bedpan, a 2-quart fountain syringe for rectal enemata, 15 yards of non-sterilized gauze and 2 pounds each of cotton batting and absorbent cotton for making bedpads, or 6 prepared sanitary bedpads, and 2 pieces of rubber sheeting, one 1 × 2 yards and the other 1 × 1½, for protecting the bed. In addition to the above-mentioned requisites the following articles should also be obtained from the drug store at least one month before the expected date of confinement, so that they may be in readiness in case labor should occur unexpectedly:

100 cubic centimeters Squibb's chloroform
1 quart alcohol
4 ounces boric acid
2-ounce tube of green soap
100 bichloride tablets
1 ounce tube of petrolatum
4 drams ergotole
1 nail-brush
2 pounds absorbent cotton

If one has a large obstetrical practice it is advisable to have some reputable druggist arrange and keep in stock a box containing the above-mentioned articles, so that the patient can be told simply to buy an obstetrical outfit.

Below is given the card for the nurse, which I prepared while engaged in private practice, containing directions for the preparations before and at the time of labor, as well as for the care of the mother and baby afterward:

Directions for Obstetrical Nurse

PREPARATIONS BEFORE LABOR

(*a*) If the patient is to be delivered at home, see that she has procured a "Confinement Outfit," and the other articles called for in "Directions for Patients," which include everything you or I shall need except baby clothes.

(*b*) Prepare a sufficient number of sterile vulval pads.

(*c*) A week before the expected date of confinement prepare seven packages, three containing six towels or diapers each, one containing leggings, two containing gauze sponges, and another containing cotton pledgets. Carefully sterilize and label them.

AT TIME OF LABOR

(*a*) If the patient is to be delivered in the hospital, take her there as soon as pains are recurring at ten-minute intervals. If, however, she is to be delivered at home, and pains begin between 8 A.M. and 11 P.M., notify me promptly, so that I may know that labor has commenced and make my plans for the day accordingly. But if labor begins after bedtime, do not notify me until morning, unless you think it necessary for me to see the patient at once.

(*b*) At the commencement of labor prepare two large pitchers of boiled water. Keep one hot and allow the other to cool, covering each with a clean towel.

(*c*) When labor has definitely set in, give the patient a warm bath and a soapsuds enema.

(*d*) Make up the bed on the *left* side (personal preference).

(*e*) Procure a piece of oilcloth or an old rug to protect the floor.

(*f*) Don't give vaginal douches of any kind.

(*g*) Don't examine patient vaginally under any circumstances.

(*h*) To prepare for vaginal examination place the patient upon a douche pan, and cut or, preferably, shave the pubic hairs. Then wash the genitalia thoroughly from above downward (toward the anus) with soap and warm water, taking care that the soapsuds and rinsings do not come in contact with the vaginal opening. I shall take care of the rest of the cleansing.

(*i*) Before a vaginal examination, drape the patient with a clean sheet in order to minimize exposure, and when the birth of the child appears imminent, roll the nightgown up above the patient's hips and pin it in position, then put on the obstetrical leggings.

AFTER LABOR

(*a*) As soon as labor is over, cleanse the genitalia with cotton pledgets and water, and then bathe with bichloride solution, after which apply a sterile vulval pad and place the patient upon a sterilized bedpad.

(*b*) Don't use an abdominal binder, unless especially directed.

(*c*) Change vulval pads as often as necessary, washing the genitalia each time with a 1 : 4000 bichloride solution.

(*d*) Take temperature and pulse four times a day (8, 12, 4, and 8), unless otherwise directed, and record upon chart.

(*e*) Don't catheterize unless the bladder is distended, and not until after the patient has failed to urinate in a sitting position.

(*f*) Give 1 ounce of castor oil on the third morning after labor, and repeat in four hours if not effectual.

(*g*) Bathe nipples with saturated boracic solution before and after each nursing.

(*h*) Watch carefully for cracked nipples, and report them to me at once.

(*i*) Diet: First twenty-four hours, milk, soup, tea, coffee or cocoa and buttered or soft toast. Second and third days, as above, with the addition of boiled or poached eggs, raw or stewed oysters, chicken breast, and wine jelly. Fourth and fifth days, as above, with the addition of sweetbreads, steak, chops, potatoes, rice, and fruit. Then return to ordinary plain diet.

CARE OF CHILD

(*a*) Leave the baby alone until the mother is cared for, wrapping it in a woolen cloth and putting it in a safe place. (Not upon the mother's bed or upon chairs.)

(*b*) I will instil the silver nitrate into the eyes.

(*c*) Cleanse the child thoroughly with albolene or sweet oil, but do not give it an initial bath. Afterwards, give a daily lap bath with castile soap and warm water, but do not give a full bath until the cord has come off.

(*d*) Dress the cord with boric acid powder and sterile cotton, or an alcohol dressing.

(*e*) Feeding: Until the milk appears, nurse three times a day, and don't give any other food unless directed. After the milk appears, let the child suckle, except before its bath, *every four hours by the clock*, from 6 or 7 A.M. to 10 or 11 P.M. Time one feeding so that it will come directly after the bath, after which the child may be allowed to sleep as long as it will.

Feed only *once*, or preferably not at all, between bedtime and 6 or 7 A.M.

As soon as the milk appears, write out a schedule for nursing and adhere to it, awakening the child at each feeding time if necessary.

(*g*) Weigh the child twice a week and record the result.

Preparations on the Part of the Physician.—When the physician has promised to attend an obstetrical patient he should hold himself in readiness to respond promptly at any hour within two weeks of the expected date of confinement, and should instruct the patient as to the best method of communicating with him without delay. If he is obliged to leave town about that time, he should notify the patient and arrange for a competent substitute to take his place if necessary. He should also remember that the proper care of such cases requires a great deal of time, and frequently no small sacrifice of personal convenience, and if he is not willing to place himself at the disposal of his patients, as far as may be necessary, he should refuse to attend them. Undue haste is one of the most frequent causes of unsatisfactory results in this branch of medicine.

The physician in private practice should provide himself with an *obstetrical kit,* which should be neatly packed in an appropriate valise and be kept ready for immediate use. It should contain not only the instruments which he may need, but also the various drugs required for hand disinfection, anesthesia, and the usual emergencies, as well as a supply of sterile towels and dressings, in case the patient has failed to provide herself with such materials, and for emergency cases. The obstetrical valise should contain a pelvimeter, 4 per cent mercurochrome solution, nail clippers and a nail cleaner, chloroform, alcohol, bichloride tablets, green soap and nail brush, sterile petrolatum, ergotole or fluidextract of ergot, pituitrin, tablets of sodium chloride for preparing normal salt solution, and a hypodermic syringe with the usual tablets. There should also be a chloroform inhaler, a suit of white clothes, and several sterilized roller bandages for packing the uterus. Glass tubes containing sterile catheters, catgut and silkworm-gut sutures, and bobbin for tying the cord are also needed, as well as a leg holder, and a Kelly perineal pad for operative cases.

The following instruments for repairing perineal and cervical lacerations should be ready for immediate use in a sterilized package: A pair of scissors, a needle holder, four artery clamps, dissecting forceps, long dressing forceps, bullet forceps, a Simon speculum, and also an assortment of needles. The valise should also contain a tin box, 40 × 13 × 10 centimeters, provided with a lid and wooden handles. In this the various instruments can be packed when not in use, and at operations it serves as a boiler and as a receptacle for them after sterilization. A Tarnier axis-traction, or an ordinary Simpson forceps, should be carried, according as the physician has become accustomed to the one or other instrument, as well as a 3-quart fountain syringe with a glass nozzle for intrauterine, and a hollow needle for subcutaneous injections of salt solution. The latter should be sterilized in advance and wrapped in a sterile towel, so as to be ready for immediate use.

This list does not include the instruments required for the destructive operations, as they are not usually carried by the general practitioner. Everything mentioned in the above list may be packed into a satchel measuring 20 × 10 inches at its base.

Conduct of the First Stage of Labor.—As soon as the nature and severity of the pains indicate that labor has set in, the patient should receive a full bath and a rectal enema. When the physician arrives he should make a careful external examination, map out the presentation and position of the child, and listen to the fœtal heart. If the pelvis has already been found to be normal, and the vertex is firmly engaged, there is no necessity for making a vaginal examination, provided that the heart sounds are in good condition. Information concerning the degree of dilatation of the cervix can be obtained by rectal examination, while the extent to which the head has descended into the pelvis can be ascertained by the fourth maneuver in abdominal palpation, and later by palpation through the perineum. Again, the rupture of the membranes and the onset of bearing-down pains usually indicate the beginning of the second stage. If examination shows that labor is not well advanced, there is no necessity for the physician to remain with the patient, and he may leave to return again in a few hours. He should not, however, leave the house if the external os is fully dilated in a primiparous woman, or half dilated in a multipara, as in the latter the first stage is frequently very short, and the second occasionally terminates with a few expulsive pains.

In general, if no abnormality is suspected, and the physician is well trained in the technic of abdominal palpation and rectal examination, vaginal examinations are unnecessary unless labor is unduly prolonged. The latter should be avoided for two reasons: to minimize the possibility of infection and to save the feelings of the patient as far as possible.

Procedure in Hand Disinfection.—It is now generally admitted that it is impossible to render one's hands absolutely sterile, no matter what method of disinfection may be employed. Even after the most rigorous directions have been scrupulously followed, there still remains a not inconsiderable danger of infection.

With the view of still further minimizing these risks, the use of rubber gloves has been introduced. These can be rendered absolutely sterile by boiling, and, when drawn over the carefully disinfected hands, afford the greatest safety possible. Since, however, they are liable to tear occasionally, the necessity for disinfecting the hands before putting them on is apparent. But their employment, even in conjunction with all our other precautions, does not entirely do away with the possibility of introducing pyogenic bacteria into the genital tract, since I have shown that they may be carried up from the vaginal outlet by the sterile gloved finger. As early as 1898, I demonstrated that pathogenic organisms are present upon the inner surfaces of the labia and the margins of the hymen in at least 60 per cent of pregnant women, and that the mere introduction of a sterile glass speculum 2 centimeters in diameter, which is no larger than the two fingers employed for examination, carries micro-organisms into the vagina in one-half of such cases. Moreover, inasmuch as the delicate structure of the parts renders their thorough disinfection out of the question, and as the examining fingers necessarily come in contact with them, it must be admitted that vaginal examinations during labor can never be entirely devoid of danger, and they should therefore be avoided so far as is consistent with the welfare of the patient. While these considerations should not deter us from making as many examinations as may be necessary in abnormal cases, it should always be borne in mind that the best results are obtained by the least possible employment of the vaginal touch, and the widest possible utilization of other methods of examination.

If the hands of the physician have recently come in contact with infectious material at operation or autopsy, it is even more imperative that labor should be conducted by external manipulations alone, vaginal examinations being made only in the presence of some abnormality, and then only by the gloved hand.

In all cases the hands should be disinfected as carefully as for a major surgical operation. For years I employed the permanganate of potassium and oxalic acid technic, which was introduced by Halsted, and described by Kelly in 1891, but I abandoned it in 1917, and have since used with satisfaction the following method:

1. Cut the finger nails to 1 millimeter in length.
2. Scrub the hands and forearms up to the elbows vigorously with nail brush, green soap, and hot water, for five minutes or as much longer as may be necessary to render them macroscopically clean, paying particular attention to the nails and palmar surface of the fingers. If running water is not available, the water must be changed at least once. After changing it, remove dirt from beneath the finger nails with nail-cleaner, and renew the washing.
3. Soak the hands and forearms for three minutes by the clock in a 1 : 1000 solution of mercuric chloride or cyanide.
4. Pass directly from this to 95 per cent alcohol, and continue the soaking for another minute.
5. If the wet technic is used, the freshly boiled gloves should be immersed in a vessel containing bichloride solution or sterile water and be drawn directly over the wet hands.
6. If the dry technic is employed, the hands are dried with a sterile towel, sprinkled with sterile talcum powder and then the dry sterile gloves are put on.
7. If only a simple vaginal examination is to be made, sterile petrolatum is a satisfactory lubricant, but for operative manipulations sterile albolene is preferable.

For many years I have worn rubber gloves of medium thickness in all my obstetrical work, and cannot indorse their employment too strongly. Provided they have been properly boiled and drawn over the carefully disinfected hands with a suitable technic, they afford the patient absolute protection against infection by the physician's hands; but, as has already been indicated, they offer no guarantee against infection by bacteria which may be carried up from the external genitalia. The objection that the use of gloves interferes with the sense of touch is not valid, as I know from my own experience, as well as that of a large number of assistants, that it can be overcome by practice, and, with the one exception of rupturing the membranes, the most delicate procedures may be conducted just as satisfactorily with the gloved hand as with the bare hand. Consequently, I urgently advise any one expecting to practice obstetrics to become accustomed to their use at the beginning of his career.

Theoretically, the wet technic would seem preferable to the more convenient dry technic, for the reason that the fingers soon begin to sweat, with the result that bacteria which are in the deeper layers of the skin come to the surface, so that after a little while the tips of the glove fingers come to contain an emulsion of bacteria, desquamated epithelium and sweat. As long as the glove remains intact this is a matter of indifference, but should it be punctured by a needle or in any other way the emulsion is extruded into the wound. If the glove contains a small amount of bichloride solution, the growth of the bacteria may be at least inhibited; while if a dry glove has been used such inhibition is out of the question, and the possibility of infection would seem to be increased.

An equally important prophylactic measure directed against infection consists in the greatest possible utilization of rectal examination with the gloved index finger. In nine cases out of ten it enables one to ascertain with accuracy the degree of dilatation of the cervix and the position of the presenting part in the pelvis. Furthermore, it has the additional advantage of not requiring disinfection on the part of the physician or the patient, as the nonsterile glove is drawn directly over the unwashed hand, the glove being boiled and the hand washed after completion of the examination. After many years' experience, I have no hesitation in stating that in the conduct of labor vaginal examination should be made only after the findings on rectal exploration prove unsatisfactory.

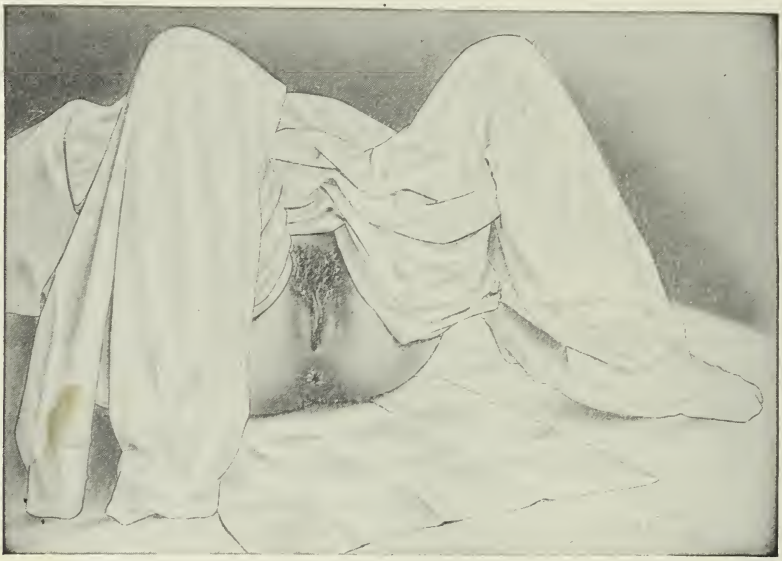

Fig. 327.—Showing Proper Method of Covering Patient with Sheet before Making a Rectal or Vaginal Examination.

Preparation of Patient for Examination.—When directed by the physician, the nurse should prepare the patient for abdominal palpation and rectal examination. She should lie on the right or left side of the bed, according as the physician prefers to use his right or left hand. She should then be covered with a sheet, and the night gown rolled up as far as the costal margins. The sheet should be so arranged that by turning down its upper end the abdomen can be exposed for palpation, while its lower ends are so wrapped about the legs as to leave the external genitalia free with the least possible exposure of the patient.

If, after completing the rectal examination, it seems essential to examine by the vagina, the patient should be placed upon a douche pan and the pubic hairs cut short with scissors or shaved. Then, instead of the cleansing with soap and water, followed by 1 : 1000 bichloride solution, as was formerly customary, the external genitalia and the surrounding parts are freely painted with a 4 per cent solution of mercurochrome in equal parts of acetone and alcohol. For this purpose a large gauze sponge, held by means of a large artery clamp, is soaked with the solution, which is then freely applied over the symphysis, the inner surface of the thighs and the outer surface of the labia majora, taking care to avoid the vaginal opening and the anal region. A second sponge is used to paint the vaginal opening and perineum, and finally the anal region. When this preparation is concluded, a sterile towel should be placed under the patient's buttocks, so as to prevent the examining hand from coming in contact with the bed.

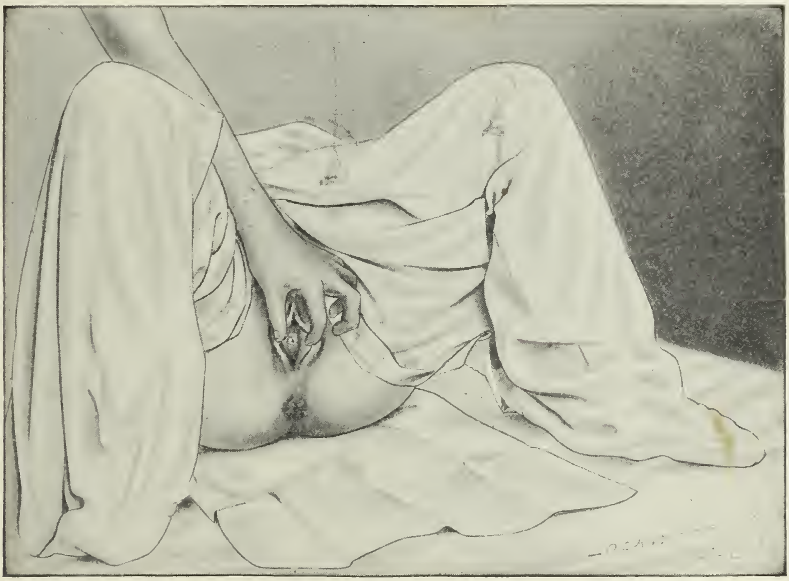

Fig. 328.—Illustrating Spreading Apart the Labia before Making a Vaginal Examination.

The application of mercurochrome is repeated before each vaginal examination, as well as before the patient is finally draped with sterile dressings at the time of delivery. Mayes, of the Methodist Episcopal Hospital of Brooklyn, goes even further and since 1926 has recommended the instillation of a 4 per cent aqueous solution into the vagina at the onset of labor, and repeats it at intervals of eight to twelve hours, as well as whenever any operative procedure is to be undertaken. He claims that the practice has reduced the puerperal morbidity by at least 40 per cent. If he is correct, it should be generally adopted, and I am now engaged in giving it a searching test.

Upon watching the usual technic of cleansing of the external genitalia and observing that the soapy water almost unavoidably comes in contact with the vaginal opening, it occurred to us that the method employed might increase rather than minimize the possibility of infection. Upon my suggestion, Johnston and Siddall subjected the question to a clinical test by delivering a series of patients, in which every alternate woman was prepared as usual, while the others received no preparation except clipping the pubic hairs. Their observations, which were published in 1922, showed that the incidence of febrile puerperia was 16.3 and 12.4 per cent in the two series, respectively, and indicated that if there was any difference it was slightly in favor of nonpreparation. I have not yet had the courage to advocate complete nonpreparation, although it is possible that the use of mercurochrome may amount to the same thing.

Method of Making a Vaginal Examination.—After the patient has been properly prepared, the thumb and forefinger of one hand distend the labia widely, so as to expose the vaginal opening and prevent the examining fingers from coming in contact with the inner surfaces of the labia and the margins of the hymen, while the index and second fingers of the other hand are introduced into the vagina.

In making the examination a definite routine should be followed: 1. The fingers should be introduced along the anterior surface of the vaginal wall, and the shape and size of the pubic arch and the height of the symphysis noted. 2. The cervix should then be examined in order to determine whether its canal is obliterated, the degree to which the external os is dilated, and the character of its margins. Next we observe whether the membranes are intact or not, great care being taken to avoid rupturing them if the patient is in the first stage of labor. 3. If the os be dilated, the presentation and position of the child should be made out, and the relation of the presenting part to the superior strait and to the line connecting the ischial spines determined. 4. After having decided these points the palmar surface of the fingers should be directed posteriorly, and the perineum palpated between the two fingers in the vagina and the thumb outside, with special reference to its consistency, thickness, and resistance. 5. The mobility of the coccyx should then be tested, after which the fingers should be passed upward over the anterior surface of the sacrum and its vertical and lateral curvature noted. If the presenting part is not low down, the three lower sacral vertebræ are readily palpable in normal women, whereas the first and second can be felt only in contracted pelves. 6. If the presenting part is not deeply engaged, and the diagonal conjugate has not been measured at the preliminary examination, its length should now be determined.

After completing the examination, the physician is usually expected to express an opinion as to the probable course of events. If everything is normal, he should assure the patient that all is well, but he should guard against making any precise statement as to the probable duration of labor, and be content with saying that in the circumstances the average time is a certain number of hours, and that her suffering will probably be ended within that period. The obstetrician who ventures to make more precise statements will speedily find that his predictions are often very faulty, even when the head is on the perineum. If some abnormality be present it is not always wise to inform the patient of the fact, but the physician should be careful to impart his knowledge to some responsible member of the family for his own protection.

During the first stage of labor the patient usually prefers to move about her room, and frequently is more comfortable when occupying a sitting position. During this period, therefore, she should not be compelled to take to her bed unless she feels so inclined, and when she does so she should be cautioned against attempting to hasten labor by voluntarily bringing her abdominal muscles into play, for they have no effect upon the dilatation of the cervix, and the effort will only serve to exhaust her strength.

Conduct of the Second Stage of Labor.—The beginning of the second stage of labor is usually indicated by the rupture of the membranes and the onset of bearing-down pains, though these signs are not altogether characteristic, as rupture may occasionally occur at an early period, or the patient may attempt to hasten the course of labor by making premature use of her abdominal muscles. On the other hand, the membranes sometimes remain intact until they protrude from the vulva. In still rarer cases they do not rupture at all, the child coming into the world surrounded by them, or, as it is popularly termed, being born with a *caul*.

In the latter part of the first stage the pains generally become so severe that the patient instinctively seeks the recumbent position; but if she is still moving about the room or sitting up, she should go to bed immediately upon the rupture of the membranes and the beginning of bearing-down pains.

Preparation of the Bed.—If the patient is to be delivered at home, the bed should be prepared as soon as the pains become severe, since in the case of a multiparous woman the second stage of labor may be so short as to leave no time for such preparations. A high single iron bedstead is preferable, but one frequently has to be content with the ordinary double bed. In such circumstances one side of it should be prepared for the patient; whether the right or left depends upon which hand the physician expects to use for vaginal examination and the conduct of labor. A large piece of rubber sheeting, 1 × 2 yards, should be placed over the center of the mattress, covering its entire width, and over this a sheet is spread. A second piece of rubber sheeting, 1 × 1½ yards, is placed upon the side of the bed upon which the patient is to lie, in such a position that it will come directly under her buttocks. The entire bed is then covered by a draw-sheet; over this is placed a sterile bed pad, upon which the buttocks rest. With this arrangement, the upper sheet and the smaller piece of rubber cloth can be removed at the completion of labor, leaving the mattress protected by the large piece of rubber sheeting and the under sheet. In ordinary deliveries I have abandoned the use of the rubber obstetrical pad, and have replaced it by sterile, absorbent bed pads. The former is very difficult to keep clean, and owing to the iregularities of the surface of the bed frequently defeats the purpose for which it was devised, in that the fluid which collects in it escapes over the bed and under the patient. To avoid exposure, the legs should be encased in long leggings, which reach to the thighs and are pinned to the rolled-up nightgown. In winter these may be made of canton flannel and in summer of thin muslin.

Examination of the Patient.—After the patient has been put to bed, the question arises whether or not a vaginal examination should be made, and this is determined by the condition of affairs in each case. If abdominal palpation shows that the head is deeply engaged, it should be omitted; but if the presenting part is not engaged, or any abnormality is present or suspected, an internal examination is absolutely necessary in order to ascertain whether the cord has prolapsed, or if everything is as it should be.

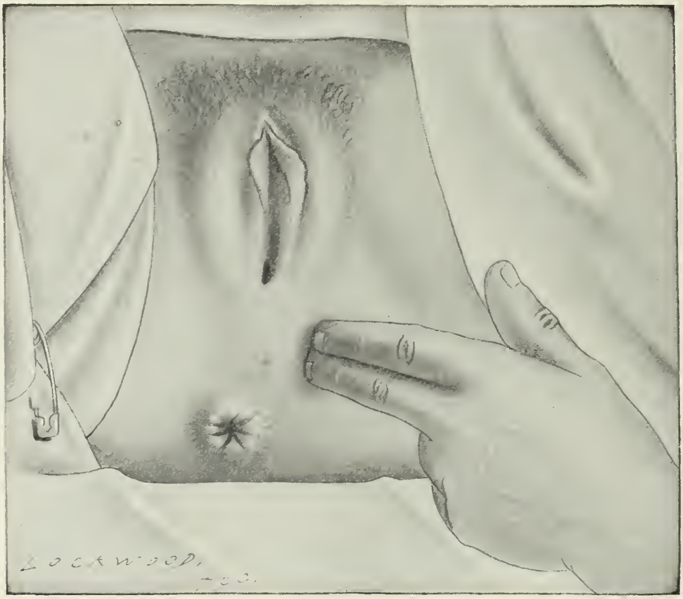

FIG. 329.—PALPATING HEAD THROUGH PERINEUM.

If the patient has apparently been in the second stage of labor for some time without rupture of the membranes, a vaginal examination is advisable in order to determine the condition of the cervix; for, after it has become completely dilated, the membranes have served their purpose and retard the birth of the child, so that it may be advisable to rupture them artificially. Formerly this was usually accomplished by sawing through them with the finger nail, or by pinching them between the two examining fingers, but this cannot be done when rubber gloves are worn, so that is becomes necessary to resort to instrumental means. For this purpose a sterilized bullet forceps is admirably suited, but if it is not available, a sterilized safety pin is a convenient substitute. The membranes should not be ruptured during the acme of a pain, particularly when the head is not engaged, as occasionally it happens that the rush of amniotic fluid may carry the cord along with it, and thus bring about its prolapse. The beginner should always be careful to differentiate between the distended membrances and a tense caput succedaneum.

Ordinarily in the second stage of labor the necessary information can be obtained by rectal exploration, but when vaginal examination becomes necessary the most rigid aseptic technic should be observed. Furthermore, it should be remembered that after the head has become engaged, its descent can readily be followed by the increasing difficulty with which the cephalic prominence can be felt on employment of the fourth maneuver, for, so long as the latter can be palpated, one knows that the most dependent portion of the vertex lies above the level of the ischial spines. Moreover, when the cephalic prominence can no longer be felt from above, if the legs are widely separated and the tips of the fingers applied to the perineum, to the side of and in front of the anus, and pressed firmly inward and upward, the presenting part can be felt as a firm, rounded body. Generally speaking, this maneuver becomes available as soon as the head has passed below the level of the ischial spines.

Throughout second stage auscultation should be practiced at frequent intervals, particularly when the head has reached the pelvic floor, for occasionally the cord is pressed upon tightly, and the child may become asphyxiated at this period and be lost, if not delivered promptly.

Delivery.—As soon as the head can be palpated through the perineum preparations should be made for delivery. A table should be placed in a convenient position at the side of the bed, and upon it a basin of boiled water and another of 1:1000 bichloride solution, as well as sterile cotton pledgets or gauze sponges, a certain number of sterile towels, and the material for tying the cord. The instruments needed for the repair of the perineum should also be within easy reach.

The patient should then be placed in position upon the bed. In this country it is customary for her to lie upon her back with the legs drawn up, though in England and many places on the Continent the lateral position is preferred. I prefer the former, as it affords better facilities for the preservation of an aseptic technic. The nightgown should be rolled up beneath the patient's back, so that it may not be soiled, and a final application of mercurochrome made to the external genitalia.

After having drawn freshly boiled gloves over his carefully disinfected hands, so that he may make an immediate vaginal examination if necessary, the physician should encase the patient's legs in sterile leggings, and, while they are held up, a sterile sheet should be so placed as to extend from the patient's buttocks to the foot of the bed. A sterile absorbent pad is then put under the buttocks, and sterile towels are placed over the abdomen and legs of the patient and pinned in position, so that everything with which the physician's hands may come in contact is covered by sterile dressings, leaving only the vulva and perineum exposed.

As the head passes down into the pelvis small particles of feces are frequently expelled, and as they appear at the anus they should be wiped away with a piece of cotton, after which the parts should be sponged off with fresh pledgets soaked in bichloride solution.

As soon as the head begins to distend the vulva, the patient's sufferings become greatly increased, and are frequently excruciating. If anesthesia has not already been induced, its use should be begun at this stage, partly to relieve the pain, and partly to aid in protecting the perineum. Directions concerning the choice of an anesthetic and its mode of administration will be given on page 385.

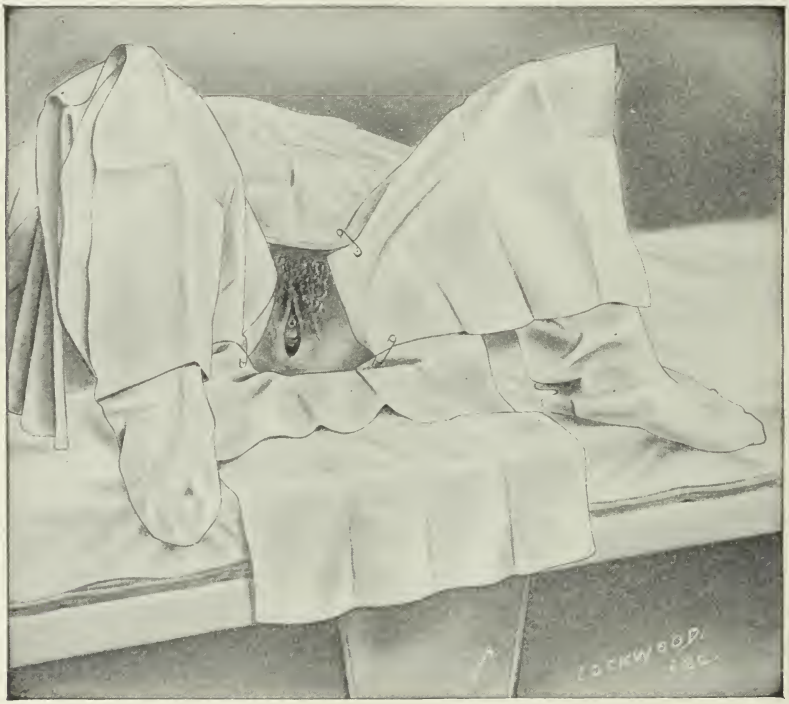

Fig. 330.—Showing Patient Covered by Sterile Dressings and in Proper Position for Delivery.

Protection of the Perineum.—As soon as the perineum shows signs of bulging the physician should make preparations for its protection, placing himself in such a position as to be able effectually to check the progress of the head if necessary.

Injuries to the perineum are of very frequent occurrence, and cannot always be avoided even under the most skilful treatment. The statements as to their frequency vary considerably, but all authorities agree that they occur much oftener in primiparous than in multiparous women. Thus, Schroeder observed them in 34.5 and 9 per cent of his cases respectively, and Olshausen in 21.1 and 4.7 per cent. These figures would seem to be too conservative, as in my experience slight tears implicating the fourchet occur in about two-thirds of all primiparæ, and in 10 per cent of multiparæ. Occasionally one meets with physicians who state that they have delivered several thousand women with one or two, or possibly without a single, perineal tear. Such statements, however, merely indicate that the physician has not inspected the parts after labor, and designates as torn only those cases in which the vagina and rectum have been converted into a cloaca, to the existence of which his attention would assuredly be called by the patient.

In the greatest number of cases the fourchet alone suffers, but not uncommonly the tear extends through a greater or lesser portion of the perineal body and is usually associated with another extending some distance up one or both vaginal sulci, while in rare cases the entire perineum is torn through and the rectum opened up. The first two varieties are frequently unavoidable, but the common occurrence of complete tears is an indication of negligence.

Generally speaking, the causes of rupture are fourfold: disproportion between the head and the vulva, too rapid expulsion, abnormalities in the mechanism of labor, or a narrow pubic arch. Where the head is unusually large or the vulva excessively small, the mechanical conditions are such that birth cannot take place without a certain amount of laceration. In not a few cases the tearing is due not so much to absolute disproportion between the head and the vulva as to the lack of elasticity of the tissue, which is particularly marked in elderly primiparæ. Too rapid expulsion, however, is a much more frequent cause of rupture, and when the head is suddenly and forcibly extruded through the imperfectly distended vulva its mode of production is manifest.

Various abnormalities in the mechanism of labor favor rupture of the perineum. The most frequent of these is imperfect extension of the head, so that the vulva is distended by the occipitofrontal, instead of the suboccipitobregmatic or suboccipitofrontal circumference. In a certain number of cases the presenting part may be directed so far backward—in other words, extension does not occur—that under the influence of the uterine contractions the presenting part is forced directly downward upon the perineal body, instead of being guided upward and forward toward the vulval opening. A similar condition is observed in women having a funnel pelvis, in which the pubic arch is long and narrow, whereby the head is prevented from engaging directly under the symphysis pubis. Again, in rare instances, an abnormal inclination of the pelvis, by causing the vulval opening to look more upward than usual, may bring about a similar condition. In considering the mechanism of labor, we directed attention to the factors which predispose to perineal rupture, when the head is delivered in persistent occipitoposterior positions, or when the child presents by the brow, face, or breech.

Giffard, in 1733, was the first to direct attention to the advisability of attempting to prevent perineal tears, and very precise directions were given by John Harvie in 1767. Numerous devices have since been suggested having the same object in view, but their very multiplicity argues that they are not uniformly satisfactory. In most of the older methods pressure was applied directly to the perineum, or various attempts were made to relieve the tension to which it was subjected, so that the physician was said to support the perineum. An excellent *résumé* of the early literature upon the subject will be found in Goodell's scholarly article, published in 1871.

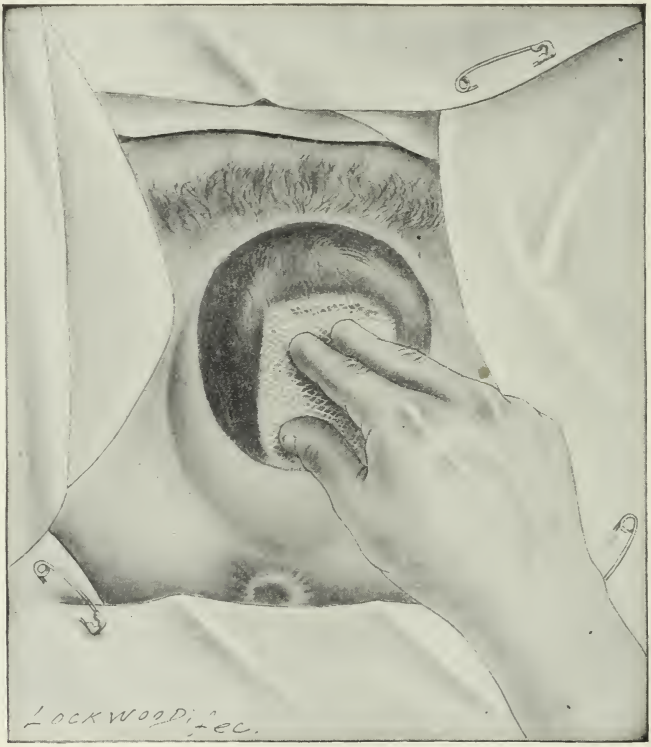

Fig. 331.—Method of Holding Back Head to Protect Perineum.

In the method which has stood me in best stead, no attempt is made to support the perineum by pressure, but the obstetrician simply endeavors to favor extension of the head and prevent it from being suddenly extruded during the acme of a pain. For this purpose during each pain, when the vertex distends the vulva widely, forcible pressure should be made against the head by the thumb and three fingers of one hand in such manner as to bring the occiput, and later the nape of the neck, directly in contact with the inferior margin of the symphysis, and thus increase extension. Accordingly, as soon as the head appears at the vulva, the physician should be ready to restrain its progress. He should hold his hand in such a manner as to be able to bring it immediately into action, for in many instances the resistance of the vulva is unexpectedly overcome, and a single pain may be sufficient to push the head suddenly through it with a resulting perineal tear. After the head is so far born that the vulva is distended by the parietal bosses, it may be advisable to attempt to express it by *Ritgen's method* in an interval between the pains. For this purpose, the patient having been instructed to open her mouth and not to attempt to bear down, the anesthesia is deepened. At the same time two fingers are applied just behind the anus, which is covered by a sterile towel, and forward and upward pressure is made upon the brow through the perineum. I, however, only employ the method when spontaneous expulsion is delayed.

The student is warned from attempting to protect the perineum by any method which aims at stripping it back over the presenting part, as such a procedure is useless, even if carried out successfully. The same may be said of the introduction of the finger into the anus, for the purpose of drawing the perineum up over the head, as suggested by Goodell. In fact, all such procedures are not only of questionable utility, so far as the protection of the perineum is concerned, but are dangerous in that they contaminate the hand and throw it out of function in case an emergency should arise which calls for its prompt introduction into the genital tract.

Formerly, it was customary to introduce one or two fingers into the vagina as soon as the head reached the pelvic floor, so that it might not surprise the obstetrician by a sudden advance. Such a practice is reprehensible, as it increases the possibility of contamination and infection.

Many authorities, when rupture of the perineum seems imminent, advise the performance of *episiotomy*. In this operation a strong pair of scissors is introduced between the head and the perineum, and an oblique incision made downward and backward on one or both sides between the anus and the tuber ischii. The operation is practiced in the belief that the vulval opening, if sufficiently enlarged by the incision, will not tear farther, or that in any case the laceration will occur in the continuation of the incision, whose clean-cut edges can be united more accurately than those of the irregular spontaneous tears. Personally, I rarely employ the procedure, as my experience is that ordinary perineal tears will heal almost uniformly if properly sutured and cared for. On the other hand, many of my associates resort to it frequently, so that it may be said that its employment is largely a matter of taste.

In an article entitled "Shall We Cut and Reconstruct the Perineum in Every Primipara?" Pomeroy, in 1918, advocated making a midline incision as soon as the perineum begins to bulge, with the idea that its accurate repair immediately after delivery would prevent the development of relaxation of the pelvic floor in the future. While this may be so, it would appear to be an inadvisable routine procedure for two reasons: first, that it converts every labor into an operative one, and second, that if ideally successful its repetition would be logically called for at each subsequent delivery.

Coils of Cord about the Neck.—Immediately after the birth of the head, the finger should be passed to the neck of the child in order to ascertain whether it is encircled by one or more coils of the umbilical cord. This complication occurs in about every fourth case, and ordinarily does no harm, but occasionally the coil is drawn so taut that the vessels are constricted and asphyxiation results. If such a coil be felt, it should be drawn down between the fingers, and, if loose enough, slipped over the child's head; but if it be too tightly applied to permit of this procedure, and the head appears congested and suffused, the cord should be seized and cut between two artery clamps, and the child immediately extracted.

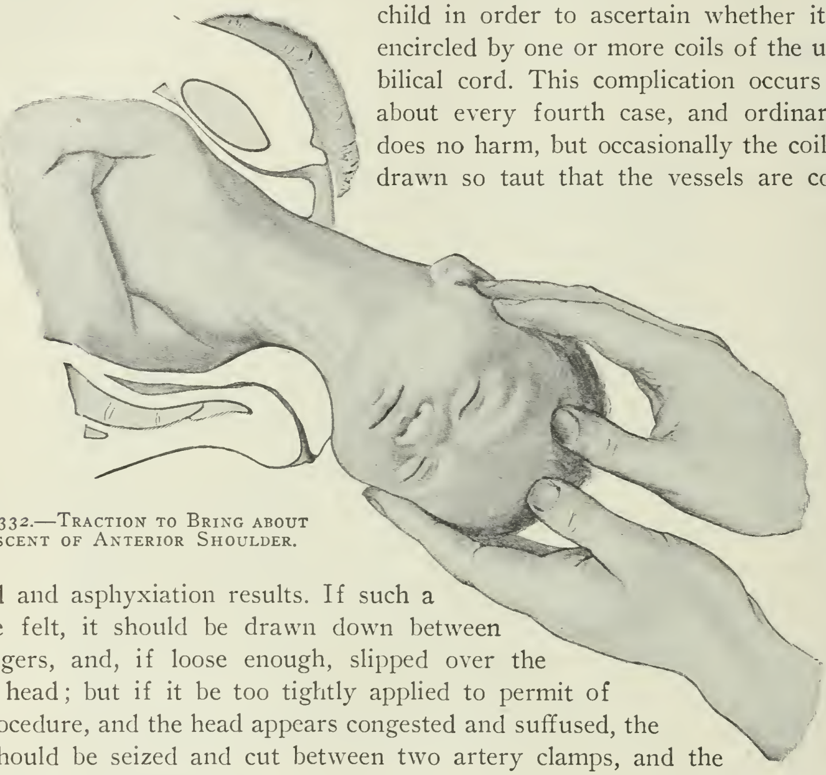

FIG. 332.—TRACTION TO BRING ABOUT DESCENT OF ANTERIOR SHOULDER.

Delivery of the Shoulders.—In the majority of cases the shoulders appear at the vulva just after the occurrence of external rotation, and are born spontaneously. Occasionally, however, a delay occurs and immediate extraction may appear advisable. To accomplish this the occiput and chin should be seized by the two hands, and downward traction made until the anterior shoulder appears under the pubic arch; next, by an upward movement, the posterior shoulder should be delivered, after which the other shoulder will usually drop down from beneath the symphysis.

The body almost always follows the shoulders without difficulty, but in case of prolonged delay its birth may be hastened by traction upon the head, or by pressure upon the abdomen, but not by hooking the fingers in the axillæ, since by the latter procedure the nerves of the arm may be injured and transient or permanent paralysis result. Indeed, even when the former method of extraction is employed, traction should be exerted only in the direction of the long axis of the child, for if it be made obliquely the neck will be bent upon the body, which excessive stretching of the brachial plexus on its convex side may occur, with subsequent paralysis.

Tying the Cord.—Immediately after its birth the child usually makes an inspiratory movement and then begins to cry. In such circumstances it should be placed between the patient's legs in such a manner as to leave the cord lax, and thus avoid traction upon it. If, however, the child does not begin to breathe immediately, the cord should be seized and cut between two artery clamps, and efforts at resuscitation commenced at once.

Normally, the cord should not be ligated until it has ceased to pulsate. In securing it, a ligature of sterilized bobbin should be applied 2 centimeters from the abdomen and tightly tied; a second ligature is placed several centimeters above the first, and the cord cut between the two. Usually ligation of the maternal end merely serves to avoid soiling the bedclothes by blood escaping from it; but in single ovum twin pregnancies double ligation is essential, for there may be such extensive anastomoses in the placental circulation that the second child, while still in the uterus, may bleed to death from the maternal end of the cord of the first. From time to time various types of clamps and other devices are recommended to replace the ligature, but, as they are rarely employed except by their inventors, it would seem that their advantages are not great.

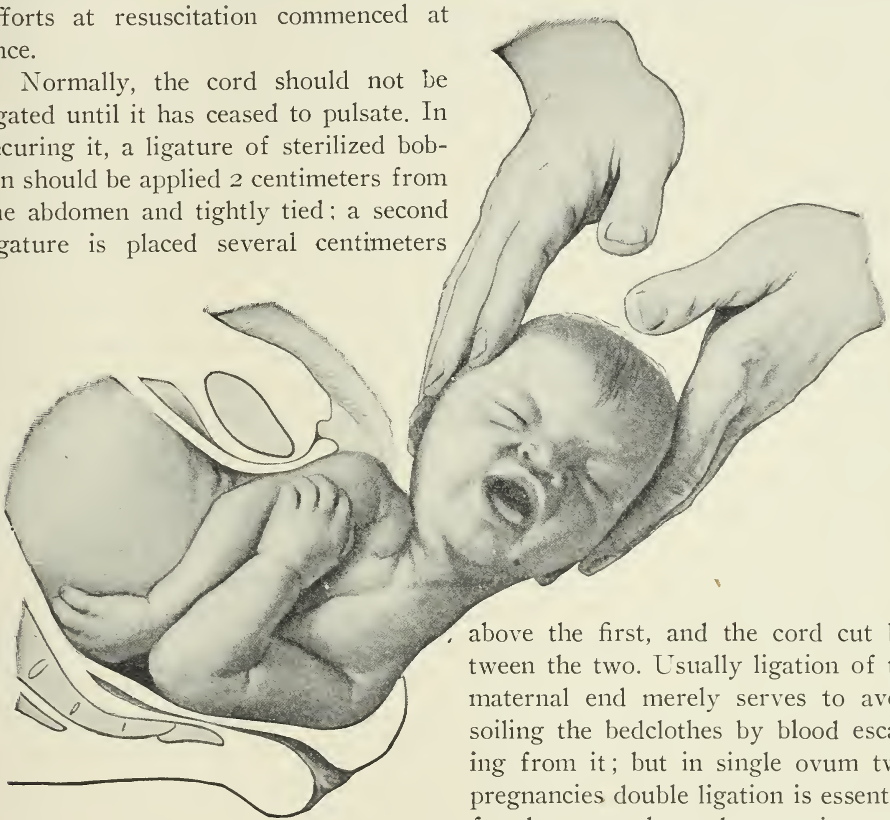

FIG. 333.—DELIVERY OF POSTERIOR SHOULDER.

The question as to the proper time for tying the cord has given rise to a great deal of discussion. Formerly it was the custom to ligate it immediately after the birth of the child; but Budin showed that 92 cubic centimeters more blood escaped from the maternal end of the cord after early than after late ligation, thus indicating that that amount was lost to the fœtus by early ligation.

Schücking demonstrated the same fact by weighing the child just after birth and again after the cord had ceased to pulsate. Budin believed that this amount of blood was drawn into the circulatory system of the fœtus by thoracic aspiration, while Schücking held that it was driven into it as a result of the compression of the placenta by the contracting uterus.

I have always practiced late ligation and have seen no injurious effects following it, and therefore recommend its employment, unless some emergency arises which calls for earlier interference.

After ligation of the cord, the child should be wrapped in a blanket prepared for the purpose, and laid in a safe place until the placenta is born and the mother has been cleaned up and made comfortable. In well equipped hospitals, a specially constructed crib, warmed by electricity, is provided for the purpose.

Anesthesia.—We are indebted to Sir James Y. Simpson for the introduction of anesthesia into obstetrical practice. He employed ether for this purpose in the year 1847, and replaced it by chloroform after he had discovered the anesthetic properties of the latter drug. Channing of Boston introduced the practice into America. Although it at first encountered great opposition from physicians, clergymen and laymen, every one now agrees as to the marked benefits derived from anesthesia when operative procedures are to be undertaken, and, except for a few who still believe in following literally the biblical injunction —"in sorrow shalt thou bring forth"—all intelligent women at present demand to be spared as far as possible from the suffering incident to the completion of normal labor.

The most generally used anesthetics are ether, chloroform, and nitrous oxide gas. Until recently it was generally believed that in actual obstetrical operations it made very little difference which was employed, as it was generally believed that the parturient woman possessed a peculiar immunity to the dangers of chloroform. Perhaps this is correct, but in recent years it has become gradually established that any prolonged administration of the drug is occasionally followed by pronounced central necrosis of the liver lobules, which may end fatally several days after delivery. Following the recognition of this danger, careful obstetricians now replace chloroform by ether or by nitrous oxide and oxygen for all operative procedures, and limit chloroform, if they use it at all, to the induction of obstetric anesthesia, or anesthesia "à la reine," as it is sometimes called. For this purpose, it is preferable to ether, and I believe is practically devoid of danger when properly administered. In home practice, I consider it the anesthetic par excellence, although in hospital practice, where trained anesthetists are available, I always employ nitrous oxide and oxygen.

The choice of the time for the administration of chloroform, however, is of great importance, nor should it be used before the latter part of the second stage, when the head becomes palpable through the perineum. A few drops should then be poured upon the inhaler, and with the beginning of a pain the patient should be instructed to breathe in the fumes vigorously; but as soon as the contraction has ceased the inhaler should be removed, to be used again when the patient makes a sign that she feels the first indication that another is beginning. This is known as anesthesia à la reine, for the reason that Queen Victoria was the first crowned head to submit to its use, and is intended merely to diminish the sensation of pain and not to produce complete unconsciousness. When properly administered, the patient experiences marked relief after a few inhalations, but retains consciousness and is generally able to talk rationally. When the distention of the vulva is at its maximum, obstetrical anesthesia is not sufficient to abolish the pain, and at that time it is advisable to render the patient completely unconscious by increasing the dose of the drug.

By this procedure the woman is saved an immense amount of avoidable suffering, and at the same time the danger of perineal laceration is diminished. For, if the pain is minimized, and done away with entirely at the critical moment, the patient will lie still instead of tossing in bed, and there will not be the same danger of the head being suddenly expelled at the acme of a contraction, while the physician is employing his energies in persuading the patient to keep quiet, or may even be forcing her legs apart so that he may be able to protect the perineum. The amount of chloroform required for this purpose rarely exceeds 2 or 3 drams.

The administration of chloroform should not be resorted to in the first stage, except in the presence of exceptional indications. Leaving out of consideration its possible influence upon the efficiency of the uterine contractions, it is only natural that as soon as the patient has experienced the soothing effects of the drug she is extremely loath to do without it, and, once having begun, the physician may find himself forced to continue its administration, unless he possesses more fortitude than is generally the case.

Against the employment of anesthetics in labor, it has been urged that they diminish the force of the uterine contractions. This statement is partially correct, for when administered for any great length of time they undoubtedly lead to a shortening of the contractions and to a prolongation of the interval between them, as was demonstrated by the experiments of Dönhoff and Hensen. On the other hand, when exhibited only at the proper time and in no excessive amount, this objection does not hold good, and in many instances small doses even appear to stimulate the uterine contractions, and, by diminishing the sensation of pain, enable the patient to bring her abdominal muscles into full play, which she previously may have been unwilling to do, and thus hasten the completion of labor.

Again, it has been taught that anesthesia predisposes to relaxation of the uterus after the expulsion of the placenta, and thus increases the danger of postpartum hemorrhage. So far as my own experience goes, such sequelæ are not likely to occur, provided the drug has been properly administered. At the same time it must be admitted that profound anesthesia does tend toward uterine inertia, and is not without a deleterious influence upon the child.

In exceptional cases, chloroform, while diminishing the pain, appears to excite the patient. Under such conditions its use should be discontinued unless complete anesthesia is necessary. It should never be used in the first stage of prolonged labors in the hope of hastening the dilatation of the cervix, as this object is better attained by the proper administration of chloral or morphia. Ordinarily the patient is allowed to come from under the influence of the anesthetic as soon as the child is born, as its use is not necessary in the third stage of labor, except when the placenta is to be removed manually or an extensive perineal laceration is to be repaired.

Nitrous Oxide Gas Analgesia.—Although gas had occasionally been employed for the induction of anesthesia in obstetrical operations, it was not until 1915 that Webster, Lynch and Davis directed especial attention to the feasibility of inducing obstetrical anesthesia by its means. They pointed out that by the aid of modern apparatus it is possible to induce the same type of analgesia with a mixture of nitrous oxide gas and oxygen, as with chloroform administered à la reine, and that if a few whiffs of gas are given with the onset of the contraction and are replaced by oxygen as it passes off, the patient soon loses all sensation of pain, but still retains consciousness. They likewise claim that this form of analgesia has the great advantage over that produced by chloroform in that it stimulates rather than diminishes the frequency and intensity of the uterine contractions during the second stage, and thereby may actually shorten the duration of labor. Moreover, Lynch contends that its administration may be begun early in the first stage and be continued almost indefinitely without injury to the mother or child.

Having extensively employed this form of anesthesia for years, I strongly advocate its use in normal labor in hospital practice, although full anesthesia must be induced as the head passes the vulva, which sometimes requires switching over to ether for a few minutes. Furthermore, the administration of gas does not predispose to excessive postpartum bleeding, and apparently has no injurious effects upon either the mother or child.

While Lynch may be correct in stating that gas anesthesia may be safely continued for many hours, I feel that its use should be limited to the second stage; but, in view of the fact that it stimulates rather than retards uterine activity, it may be commenced as soon as the cervix has become fully dilated, instead of waiting until the presenting part has reached the pelvic floor, as with chloroform or ether. Furthermore, I believe that the method must necessarily be restricted to hospital use and to practice among the well-to-do, as the actual cost of the gas, the transportation of the more or less cumbrous apparatus, and the necessity of a trained assistant to manipulate it place it beyond the means of the ordinary patient in her own home with whom chloroform, ether, and perhaps synergistic rectal analgesia, will retain their preëminence.

In our clinic, nitrous oxide gas and oxygen, and occasionally chloroform, is administered during the second stage in all normal labors, and if, in addition, 1/12 grain of heroin be administered hypodermatically as soon as the cervix has dilated 5 or 6 centimeters in diameter, and the patient be kept in a semi-darkened room from which all unnecessary noise is excluded, the suffering is reduced to a bearable minimum, and most of the advantages attending "twilight sleep" are obtained without its disadvantages. In my experience, heroin is greatly superior to morphia in its analgesic action, and its possesses the additional advantage that it does not decrease the intensity of the uterine contractions and has no deleterious effects upon the child.

Ethylene Anesthesia.—With the popularization of anesthesia by means of ethylene gas in general surgical practice, numerous obstetricians have employed it in obstetrical work, and Heaney, Plass and others advocate it enthusiastically. I, however, have had no experience with it. Doubtless, it acts as efficiently as its advocates claim, but the fact that several serious explosions have occurred during the course of its administration makes me feel that its routine employment is not desirable.

Moreover, Henderson, on behalf of the Committee on Anesthesia Accidents, reported in 1930 that the comparatively high dilution in which the gas is used for obstetrical anesthesia makes the risk of explosion much greater than with the higher concentrations which are employed for surgical anesthesia.

Gwathmey's Synergistic Analgesia.—Since 1924, under the auspices of Gwathmey, a new type of anesthesia has been developed, in great part at the New York Lying-In Hospital, in which the synergistic effects of morphia and magnesium sulphate administered hypodermically are combined with the rectal instillation of ether. The method has been used in many thousands of patients by Asa B. Davis and Harrar, who express themselves as satisfied with it.

The technic is as follows: As soon as the cervical canal has become obliterated, the external os being several centimeters in diameter and the pains satisfactory, the patient is given a soapsuds enema, and receives intramuscularly 1/6 or 1/4 grain of morphia and 2 cubic centimeters of a 50 per cent solution of magnesium sulphate. Following this, she is kept quiet in a darkened room, with her ears plugged with oiled cotton. Twenty minutes later, a second injection of 2 cubic centimeters of the magnesium sulphate solution is given, but without the morphia. As soon as the resulting sedative action begins to wear off, the rectal instillation of ether is started. For this purpose, a mixture is prepared with the following ingredients:

Quinine alkaloid	gr.	20
Alcohol	min.	40
Ether	oz.	2½
Olive oil to make	oz.	4

The bottle containing the mixture and another bottle containing two ounces of olive oil are warmed by standing for a few minutes in warm water. The injection apparatus consists of a four ounce glass funnel and twenty inches of rubber tubing, whose free end is connected by a glass tube to a No. 22 rubber catheter.

The patient is then placed on her left side, and after anointing the anal region with petrolatum, is ready for the enema. One ounce of olive oil is poured into the funnel and allowed to flow until it escapes from the tip of the catheter. Then the tube is clamped and the catheter is introduced high up into the rectum, after which the ether mixture is poured into the funnel and allowed to flow, but just before the funnel becomes empty the second ounce of olive oil is poured into it and allowed to escape—until the entire ether mixture has passed into the rectum. Then pressure is made over the anus with a towel, and the catheter is removed, the pressure being continued until the desire to expel the enema has passed. Immediately following the enema, a third injection of 2 cubic centimeters of magnesium sulphate solution is given to reënforce the action of the ether.

Following this, the patient becomes drowsy, sleeps between the pains, but does not lose consciousness entirely. During each pain she usually complains, but goes to sleep again as soon as it ceases. The effect of the enema usually wears off within three hours, after which a second or even a third one may be given if necessary. These additional instillations, however, contain only 10 grains of quinine, instead of 20 grains as in the original instillation, and each is followed by the injection of 2 more cubic centimeters of 50 per cent solution of magnesium sulphate, but no more morphia.

Davis and Harrar believe that the quinine is absorbed from the rectum and tends to counteract the tendency of the morphia and ether to diminish the force of the uterine contractions. They express themselves as highly satisfied with the method, although in most cases a small amount of ether must be inhaled to render painless the end of the second stage. They state that the technic is applicable to about 70 per cent of all patients, and gives satisfactory results in 85 per cent of them. In general, they regard the degree of analgesia, prior to the end of the second stage, as superior to that produced by "twilight sleep."

I have had no experience with this type of analgesia for two reasons: First, because my results with nitrous oxide and oxygen have been relatively satisfactory, and second, because I cannot convince myself that it is correct to use a method which cannot be interrupted at will. Those interested in the method, and who wish to learn the objections of a pharmacologist to it, are referred to the report made by Hatcher to the Council of Pharmacy and Chemistry of the American Medical Association, in 1927.

Scopolamine-morphine Anesthesia.—This method of combating the pain of labor was introduced in 1902 by Steinbückel, who reported that the hypodermic injection of scopolamine hydrobromate and morphia practically annulled the pains of labor, even permitting the application of forceps or the artificial dilatation of the cervix.

In 1907, Gauss reported its administration in 1000 cases in Krönig's clinic in Freiburg, and stated that by a proper regulation of dosage 80 per cent of the patients would pass into a semiconscious state, which he designated as "twilight sleep." In this condition the patient appears to appreciate pain at the time, but has no recollection of it later. For this purpose he administers 0.0003 gram of scopolamine and 0.01 of morphia hypodermatically, and repeats the *scopolamine,* but not the morphia, once or several times later if necessary. The indication for its repetition is not afforded by the lapse of any specified length of time, but rather by the mental condition of the patient, who should be kept in a state of relative amnesia. This is determined by showing her some object, which she should promptly forget having seen, if sufficiently under the influence of the drug, but another dose should be administered if she possess any recollection of it thirty minutes later.

A very considerable literature has accumulated upon the subject, which has been well summarized by Lequeux, Siegel, and by a committee of the London Obstetrical Society in 1918.

Following a magazine campaign in 1914, great interest in the procedure was aroused among the laity, and obstetricians all over this country were constrained to experiment with the method, and a large number of publications of varying value have been made concerning it.

My own experience is that if 1/6 grain of morphia and 1/150 grain of scopolamine be administered when the cervical canal has been obliterated and the external os is just beginning to dilate, followed by a second dose of 1/300 grain scoplomaine one-half or one hour later, the patient passes into a somnolent condition, with a flushed face, injected eyes, and an accelerated pulse rate, and sleeps quietly, and sometimes heavily, in the interval between the pains, but complains bitterly during their continuance. Following the second dose of scopolamine, others are administered at intervals of from one and a half to three hours, according to the mental condition of the patient, but the morphia or narcofine is not repeated unless the labor is unusually prolonged. During this period the patient should be kept in a dimly lighted room from which all noise is excluded, her ears should be plugged with cotton and her eyes shaded by colored glasses, while a competent attendant should remain continually in the room. The dosage indicated is not sufficient to control the pains during the latter part of the second stage, when chloroform or nitrous oxide gas should be administered. Following the completion of labor the patient is kept in a quiet, darkened room, and upon being questioned at the end of three or four hours, is usually surprised to learn that her baby has been born, and will state that she has no recollection of what had occurred after the second or third injection of scopolamine. If the drug is not administered until late in the first stage of labor, the results are always disappointing, and her child is usually deeply asphyxiated when born.

The desired degree of amnesia is obtained in about three-quarters of the patients provided a suitable technic has been developed by those in charge. It should be added that behavior of the patient while under the influence of the drug affords no indication of the degree of amnesia; as many patients become violently excited and complain bitterly with every pain, and yet afterwards claim that they have no recollection of what has occurred. On the contrary, others, who appeared to be profoundly under the influence of the drug, recall every incident and contend that the labor was most painful.

The fact that we cannot promise a satisfactory subjective result to more than three patients out of four makes it apparent that the method is not ideal, and it is my belief that its use will eventually be restricted to a small group of neurotic patients, upon whom it is desirable to exert a psychic effect. In addition, several serious objections are inherent to this form of anesthesia. In the first place, it results in a definite prolongation of the second stage, necessitating more frequent instrumental interference, with its additional danger of infection. In the second place, it is attended by a definite, but slight, increase in the fœtal mortality, estimated at between 1 and 2 per cent, which is apparently due to direct poisoning of the fœtus. A large proportion of the children are born in an apneic condition; a smaller number are deeply asphyxiated, but can be resuscitated without great difficulty; while occasionally the asphyxia is so deep that resuscitation is impossible. It has no effect upon the maternal mortality, nor apparently upon the incidence of postpartum hemorrhage.

From my experience, the method is not adapted to practice in the home for three reasons. First, that it can only be expected to give ideal results when carried out by a trained personnel, under suitable material conditions; secondly, that in a considerable proportion of cases it is attended by a degree of restlessness and excitement, which may require physical restraint, and which makes a very painful impression upon those interested in the patient. Finally, it makes such demands upon the time and nervous equation of the physician, as to put it beyond the reach of all but well-to-do patients; as the average obstetrician cannot be expected to devote twelve or fifteen hours of continuous service to a normal delivery, which ordinarily requires but a few hours of his time.

Anesthesia with Barbituric Acid Derivatives and Avertin.—That the results obtained with scopolamine-morphine have not proven generally satisfactory, is indicated by the fact that since 1927 many attempts have been made to induce a more perfect "twilight sleep" by means of such new drugs as pernocton, amytal, and avertin.

The use of pernocton, which is a butyl-brom-allyl barbituric acid, was introduced by R. Bumm in 1927, and has since been extensively employed, especially in Germany. It is slowly administered intravenously in doses of 1 cubic centimeter for each 12.5 kilos of body weight, and the patient promptly falls into a deep sleep, almost complete amnesia being obtained, provided labor terminates within two hours of its administration. Vogt and others write enthusiastically concerning it, but it would appear that failure occurs in about 20 per cent of the cases, and that the strength of the uterine contractions is frequently so impaired that pituitrin is necessary to overcome it.

I have had no experience with pernocton, but, so far as I can gather from the abundant literature, it appears that its greatest disadvantage consists in the fact that it is frequently accompanied by such excitement on the part of the patient that it becomes necessary to restrain her by force, which is not conducive to aseptic technic.

Amytal, which is iso-amyl-ethyl barbituric acid, has been less extensively employed. It may be administered intravenously or rectally. Drabkin and Hirst reported that the rectal administration of 30 milligrams per kilo gave satisfactory results in 23 out of 30 cases, but that great excitation was noted in the others. Furthermore, they state that the uterine contractions were definitely weakened in several patients and abolished in two others.

In 1928, Hofbauer experimented with the drug in our service, and found that while the results were sometimes very satisfactory, other patients became so excited and restless that restraint was necessary to keep them in bed, so that it was impossible to maintain an aseptic technic. For this reason, I have had no inclination to continue the use of the drug.

Following the satisfactory results obtained with avertin—tri-brom-ethanol, in surgical practice, it has been employed for the production of twilight sleep at the time of labor. The rectal administration of 60 to 75 milligrams per kilo of body weight at the latter part of the first stage is sometimes followed by striking results. Rumpf considers it far superior to pernocton, while Kienlin regards it as inferior. Both state that it frequently leads to great excitement of the patient, which greatly impairs its general availability. I have had no experience with its use, but in view of its satisfactory results in operative cases, I am prepared to give it a trial. At the same time, it should be remembered that it is not innocuous, that the solution must be freshly prepared for each administration, and that great precautions must be taken in order to prevent its decomposition into the very irritating dibromacetaldehyde.

From what has just been said, it is apparent that none of these drugs can be regarded as an ideal anesthetic for obstetrical use, and it behooves the practitioner to be very cautious in accepting the optimistic reports of promotors of new drugs and methods.

Local Anesthesia.—I have had no experience with the method, but Gellhorn is enthusiastic concerning its use in the second stage of labor in conjunction with "twilight sleep." For this purpose, he employs a 0.5 per cent solution of novocaine containing three drops of adrenalin to the ounce, and injects it first along the mucocutaneous border between the vaginal outlet and the perineum. He then passes the needle into the rectovaginal septum, and finally injects 5 cubic centimeters into each side of the levator ani muscle. He claims that by this means the second stage is rendered practically painless, and that the repair of perineal lacerations is possible without further anesthesia.

Lumbar Anesthesia.—Following the rehabilitation by Bier of the subarachnoidal injection of cocaine, for the production of anesthesia of the lower portion of the body, and its popularization by the work of Tuffier, it was but natural that its efficiency should be tested upon the parturient woman.

The first publication concerning its employment at the time of labor was made in August, 1900, by Kreis. Since then a number of observers have reported series of cases treated in this manner with cocaine or some of its derivatives. It is a well-recognized fact when 50 milligrams of novacaine or spirocaine are injected into the third or fourth lumbar interspace that the patient in the second stage of labor promptly loses all sensation of pain, while the force of the uterine contractions appears to be definitely augmented. Furthermore, operations of any kind can be performed with the greatest ease.

Notwithstanding these great advantages, the method should not be employed in normal labor, but should be restricted to the occasional operative case in which general anesthesia is contra-indicated, or at least promises to add to the gravity of the underlying condition. This position is taken by Brindeau, whose large experience has taught him the advantages and disadvantages of the method, and has convinced him that the mortality connected with it is too great to justify its use in normal labor. Moreover, even so enthusiastic an advocate as Cosgrove hesitates to recommend its employment, except in the presence of certain definite abnormalities in which general anesthesia is known to be dangerous. In this connection, I should advise anyone considering its use, even in operative deliveries, to study carefully the conservative statements of Labat, from which he will learn that while lumbar anesthesia possesses many advantages, yet it is not without its dangers and limitations.

Hypnotism.—From time to time, various observers, among whom may be mentioned Leichstein, and Cocke, have reported instances in which labor was painlessly conducted under the influence of hypnotism. Latterly, its employment has been resumed, and in 1922 Schultze-Rhonholf, Kirsten and others have reported a series of cases in which it was used with extraordinary success. Personally I have seen it employed successfully in a single instance, and consider that its field of usefulness is very limited, for the reason that the patient must be a susceptible subject, and one who has already been hypnotized on previous occasions.

The Use of Ergot and Pituitary Extract.—In the past many authorities recommended the administration of a dram of fluidextract of ergot by mouth immediately after the expulsion of the placenta, as a prophylactic measure against postpartum hemorrhage, and at present many administer hypodermatically 1 cubic centimeter of pituitary extract for the same purpose. Ordinarily, both are unnecessary, and, while it has already been stated that the use of the latter is permissible, I never use the former. If, however, the uterus remains soft and flabby after massage, instead of forming a hard tumor beneath the umbilicus, the use of pituitary extract is imperative, and, if bleeding occurs, I follow it by the hypodermatic injection of 40 to 60 minims of ergotole, or some other reliable preparation of ergot, for the reason that one reënforces the other—as the action of pituitary extract is almost immediate, but only continues for a few minutes, while that of ergot is more tardy, but also much more persistent, so that the effect of the former is almost exhausted by the time that of the latter becomes manifest.

This is the only time at which ergot should be employed in labor, as its administration before the completion of the third stage has led to untold harm. Formerly, even well-trained physicians used it in large quantities during the second stage to stimulate uterine contractions, but at the present time it is so employed only by ignorant midwives. The premature use of the drug readily leads to tetanic contractions of the uterus, which in the presence of any marked disproportion between the size of the child and pelvis are likely to bring about rupture of the uterus. Moreover, its administration in the third stage of labor, before the expulsion of the placenta, cannot be too strongly deprecated, as the resulting tetanic contraction tends rather to produce a further retention of the organ, so that its manual removal frequently becomes imperative.

Conduct of the Third Stage of Labor.—This subject has already been considered in the preceding chapter.

Repair of the Lacerated Perineum.—Strictly speaking, this subject should be deferred until the obstetrical operations are dealt with, but as perineal tears are of such frequent occurrence, and as they are best repaired in the interval between the birth of the child and the expulsion of the placenta, the proper method of procedure will be considered at this time.

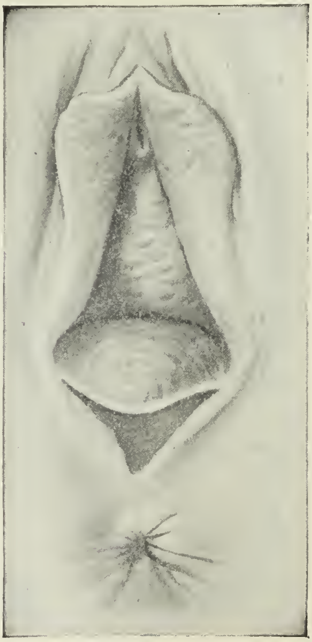

Fig. 334.—Superficial Perineal Tear.

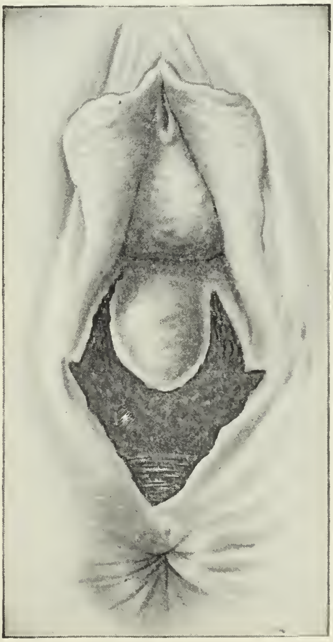

Fig. 335.—Deep Perineal Tear.

For convenience in description, perineal tears are divided into three groups, those of the first, second, and third degrees. To the first belong those which involve simply the fourchet and anterior margin of the perineum, giving rise to a small, triangular wounded surface which is rarely more than 1.5 centimeter deep.

In the second the laceration extends through a greater or lesser portion of the perineal body, and frequently exposes the sphincter ani muscle. Usually its course does not quite follow the median line, but extends obliquely downward and outward from the posterior margin of the vulva. The perineal tear is usually associated with lesions of the vagina, which extend up one or both sulci, so that a triangular portion of the vaginal mucosa, which represents the inferior extremity of the posterior column, may become separated from the rest of the canal.

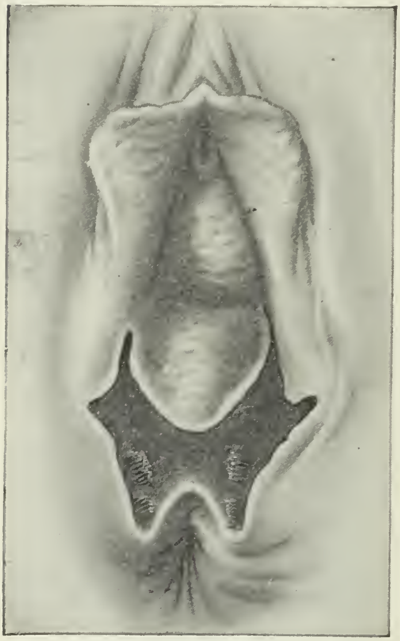

Fig. 336.—Complete Perineal Tear.

In the third degree, the tear extends completely through the perineal body and the sphincter ani muscle, and for a certain distance up the anterior wall of the rectum, thus giving rise to a cloaca, into which both vagina and rectum open. These are designated as complete, in contradistinction to those of the first and second degrees—the incomplete tears—in which the rectum is not involved. Incomplete tears are encountered very often in the practice of the most competent obstetricians, no matter what precautions may be taken to prevent them; but the frequent occurrence of the complete variety indicates that the method employed for protecting the perineum has been at fault in spontaneous, or that the extraction has been too hasty in operative, deliveries.

In tears of the first degree, the mucous membrane of the fourchet and the skin covering the upper portion of the perineum and the subcutaneous tissue are implicated; in those of the second degree, the skin surface of the perineum, the various perineal muscles, particularly the constrictor vaginæ and transversus perinei, are torn through, and the wide-gaping wound is due in great part to the retraction of these muscles. When the tear extends up the vagina, the levator ani muscle may likewise be involved; while, in lacerations of the third degree, the sphincter ani muscle and the anterior surface of the rectum are implicated in addition to the structures above named.

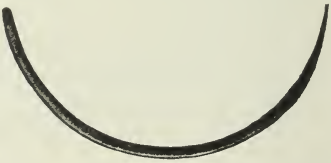

Fig. 337.—Needle for Repairing Perineal Tears.

In the rare cases in which the vulval outlet looks markedly upward, or in which the perineum is extremely resistant and the mechanism of expulsion faulty, the laceration may begin in the central portion of the perineum, when the head appears in an opening which is surrounded on all sides by skin. This is known as a *central tear,* and is of infrequent occurrence. Ordinarily, as the head is forced down still farther, the tear extends toward the fourchet or toward the anus, or even in both directions, and thus gives rise to a deep incomplete or to a complete laceration, as the case may be.

In not a few cases, where the vaginal opening is very resistant, and when the head has remained a long time upon the pelvic floor, even though there may be no external wound or appreciable lesion of the vagina, there may nevertheless have occurred a submucous tear or separation of certain fibers of the levator ani muscle, which will later give rise to a marked relaxation of the vaginal outlet. Frequently the condition, although unrecognized at the time, later gives rise to such aggravated symptoms as to call for operation years after the birth of the child.

No matter what the degree, the *immediate closure of perineal lacerations* by suture is urgently indicated. Even slight tears through the fourchet are better repaired than left alone. In more extensive tears, immediate repair is always necessary, unless the condition of the patient be so serious as to contra-indicate further operative procedures. For these operations, the patient should be brought to the edge of the bed and placed in the lithotomy position, and the sutures introduced while waiting for the expulsion of the placenta. The sutures should not be tied until the completion of the third stage, as the distention of the vulva by the placenta may subject the repaired wound to undue strain. By introducing the sutures during this period time is saved, and the temptation to hasty expression of the placenta is diminished, since the physician has something to do while waiting for the fundus to rise up.

The mode of repair differs, according as the tear extends only through the perineal body or is complicated by lacerations of the vagina or rectum. In the first case, the wound should be closed by deep sutures of forty-day chromic catgut, which are introduced a centimeter from one margin and carried well down under its base, being then brought out through the skin surface on the opposite side. It is important that the sutures should be inserted at a considerable distance from the edges of the wound, for, owing to the edema which develops later, they are very prone to tear through unless this precaution is taken. They should be placed at intervals of about 1 centimeter, and if accurate approximation is not secured superficial sutures should be placed between them. Large curved needles, which can make the entire sweep in a single movement, should be used, as they render much better service than small needles which require several bites. The sutures should be tied very loosely from below upward, and cut off short.

When the perineal tear is complicated by laceration of the vagina, the edges of the latter should be brought together by chromicized catgut sutures, just as in Emmet's relaxed outlet operation. These may be either interrupted or continuous, but in either event they should be laid deeply in order to insure coaptation of the torn structures of the pelvic floor, instead of merely bringing together the edges of the mucosa, after which the perineal wound should be repaired in the usual manner.

In complete tears, attention should first be given to the wounded rectum and its ruptured mucosa united by buried catgut sutures. Then the ends of the sphincter ani should be isolated and firmly sutured by catgut or fine silk sutures, after which the vaginal and perineal tears should be dealt with in the manner indicated above. Whenever catgut sutures are employed in any but the most superficial tears, it is advisable to place one or two deep silkworm-gut sutures as a precautionary measure, as even forty-day chromic catgut sutures may be absorbed prematurely.

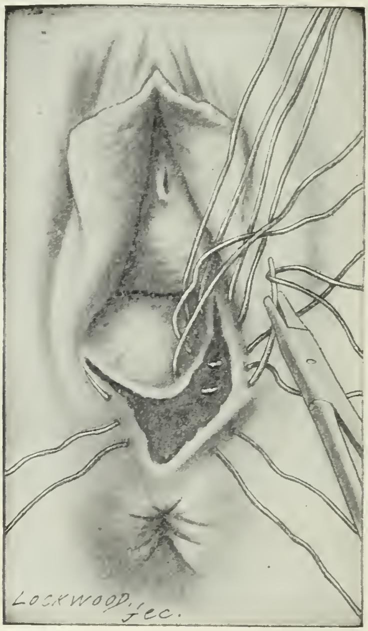

Fig. 338.—Repair of Perineal Tear Extending up the Vagina.

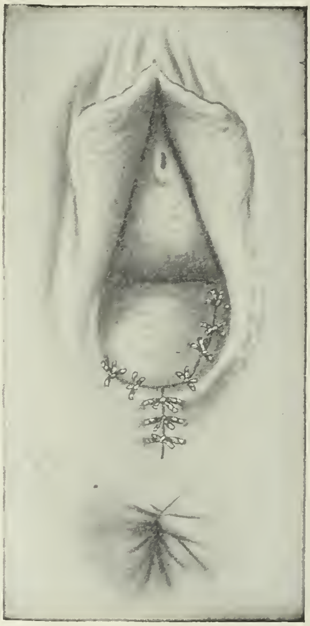

Fig. 339.—Same as Figure 338. Sutures Tied.

The after-treatment of tears of all degrees is comparatively simple, and consists in keeping the wound clean and covered by sterile dressings. The wounded surface should be washed several times a day with plain water or a 1:4000 bichloride solution, as Plass in our service demonstrated that the elaborate technic formerly employed is unnecessary and only adds to the discomfort of the patient. For this reason the use of antiseptic powders, such as iodoform or boric acid, is not indicated, as the wounds heal equally well without them. Nor is there any necessity for binding the legs together, unless the patient is very unruly. Catheterization should be dispensed with, except in cases of retention, as the flow of urine over the wound does no harm, provided it is followed by proper cleansing. If silkworm-gut sutures have been employed, they should be removed on the tenth day. In tears of the first and second degrees, the bowels should be moved daily, but in complete lacerations it is advisable to prevent an action for the first four or five days, after which a large high enema of sweet oil should be given, followed by one ounce of castor oil by the mouth.

The results following these operations are usually very satisfactory, and primary union is the rule, provided the sutures have been introduced far enough from the margins of the wound and not tied too tightly. This is a point to which too much attention can hardly be paid, for too often there is a tendency to attempt to make a neat-looking operation by introducing the sutures close to the margins of the wound and tying them snugly. As a result, the majority of the stitches cut through and become useless. On the other hand, when less attention is paid to the first appearance of the wound, the sutures being introduced far from its margins and tied somewhat loosely, excellent results almost always follow.

Unfortunately, operations for complete tears are by no means so satisfactory, and, as a general rule, not more than two-thirds of the cases heal by first intention. In the cases of complete or partial failure a secondary operation is indicated before the patient is discharged from treatment.

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CHAPTER XVI

THE PUERPERIUM

Strictly speaking, the term puerperium or puerperal state (from *puer,* a child; and *parere,* to bring forth) comprises the period elapsing between the onset of labor and the return of the generative tract to its normal condition; but in common parlance it is restricted to the five or six weeks following the completion of labor. Although the changes occurring during this period are considered as physiological, they border very closely upon the pathological, inasmuch as under no other circumstances does such marked and rapid tissue metabolism occur without a departure from a condition of health.

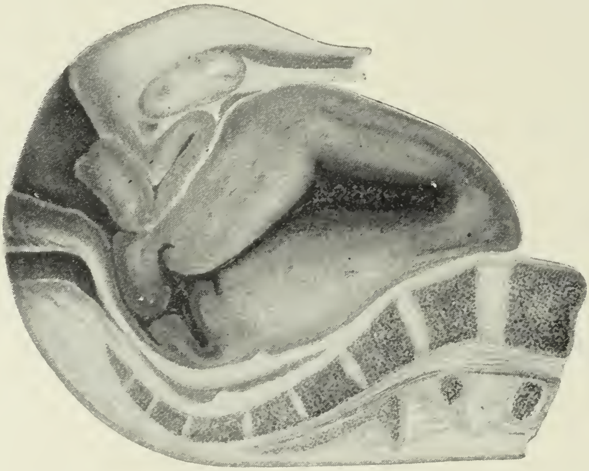

Fig. 340.—Frozen Section, Showing Uterus Immediately after Delivery (Webster).

Anatomical Changes in the Puerperium.—*Involution of the Uterus.*—Immediately following the expulsion of the placenta, the contracted and retracted body of the uterus forms a hard muscular tumor, the apex of which lies about midway between the umbilicus and symphysis, usually 12 centimeters (4¾ inches) above the latter. At autopsy, shortly after labor, it consists of an almost solid mass of tissue containing in its center a flattened cavity, whose anterior and posterior walls are in close apposition, each of which measures four to five centimeters in thickness. Owing to the compression of its vessels by the retracted muscle fibers, the puerperal uterus on section presents so anemic an appearance, as contrasted with the purplish pregnant organ, that Longridge has aptly designated it as "blood tight." At the same time a considerable portion of the tissue juices is expressed. During the next two days the uterus remains apparently stationary in size, after which it atrophies so rapidly that by the tenth day it has descended into the cavity of the true pelvis, and can no longer be felt above the symphysis. It regains its normal size by the end of five or six weeks. Some idea of the rapidity with which the process goes on may be gained by recalling the fact that the freshly delivered uterus weighs about 1000 grams, one week later 500 grams, at the end of the second week 375 grams, and at the end of the puerperium only 40 to 60 grams.

This rapid decrease in size is due to what is designated as *involution,* and is the most striking example of atrophy with which we are acquainted; in that the organ becomes reduced to one-twentieth or one-twenty-fifth of its original size within a few weeks, and, when compared with the changes occurring in acute yellow atrophy of the liver, may well be designated as "atrophia acutissima."

It was formerly believed that the muscle cells underwent fatty degeneration during involution, and that large numbers of them completely disappeared. Sänger, however, was the first to show that only the excess of protoplasm is removed, and that the actual number of individual cells is not greatly diminished. Stieve, however, contends that many of the cells completely disappear. Sänger estimated that during the process the individual cells decrease from 208.7 to 24.4 mikrons in length.

It is now held that involution is effected by autolytic processes, by which the protein material of the uterine wall is in great part broken down into simpler components, which are then absorbed and eventually cast off through the urine. The evidence in favor of such a view is afforded by the study of the nitrogen content of the urine. For the twenty-four hours immediately following labor 7 to 9 grams of nitrogen are excreted, but some time during the second or third day an increase of 30 to 50 per cent is noted. This excessive output continues for a number of days, but gradually returns to normal at about the time the uterus has disappeared into the pelvic cavity.

That this phenomenon is not entirely attributable to the removal of other products of pregnancy was clearly shown by Slemons, who, in one of my patients, from whom the uterus had been removed at cesarean section, found that the characteristic increase in the nitrogen output was lacking, and that the difference practically corresponded to the quantity of nitrogen contained in the uterus. Harding and Montgomery, on the other hand, contend that the negative nitrogen balance is in great part connected with lactation, and in certain patients, at least, can be overcome by greatly increasing the nitrogenous constituents of the diet.

As yet we know nothing of the ferments giving rise to the autolysis, but it is readily conceivable that their action is facilitated by the acute anemia of the "blood-tight" uterus. Morse, who has studied the metabolism of the puerperium, found that the creatinine content of the urine becomes markedly increased during the first few weeks and later returns to its normal level. He associates this with the process of involution, as he found that it was much less in two patients from whom the uterus had been removed by Porro's cesarean section. He also confirmed the statement of Murlin that considerable quantities of creatine appear in the urine, but was unable to determine its source. At the same time, by comparing the metabolism in normal puerperal women with that occurring after the removal of the uterus, he was able to show that the excretion of creatine is in no way dependent upon the process of involution, and that it is likewise independent of the creatinine metabolism.

As has been said before, the separation of the placenta and its membranes occurs in the outer portion of the spongy layer of the decidua, and accordingly a remnant of the latter remains in the uterus after their expulsion. It presents striking variations in thickness, an irregular, jagged appearance, and is markedly infiltrated with blood, especially at the placental site. As the result of hyaline and fatty degeneration, the greater portion of this tissue is cast off in the lochia, leaving behind only the fundi of the glands and a minimal amount of connective tissue, from which the new endometrium is regenerated.

Tht processes concerned in its regeneration have been carefully studied by Friedländer, Kundrat and Engelmann, Krönig, and particularly by Wormser, and by Teacher. They have shown that, within two or three days after labor, the portion of decidua remaining in the uterus becomes differentiated into two layers—one adjoining the uterine cavity being necrotic, and the other adjoining the muscularis being well preserved. The former is cast off in the lochia, while the latter, which contains the fundi of the glands, remains in situ and constitutes a matrix from which the new endometrium is regenerated, its epithelium resulting from the proliferation of the gland cells, and its stroma from the connective tissue between them. The process of regeneration is rapid except at the placental site. Elsewhere, the free surface becomes covered by epithelium within a week or ten days, and the entire endometrium is restored by the end of the third week.

Changes in the Uterine Vessels.—Immediately after the completion of the third stage of labor, the placental site is represented by an irregular, nodular, elevated area of about the size of the palm of the hand, the elevations being due to the presence of thrombosed vessels. This area decreases rapidly in size, so that it measures 3 or 4 centimeters in diameter at the end of the second week, and only 1 to 2 centimeters at the completion of the puerperium, although it still remains elevated above the general surface of the interior of the uterus and is tinged with blood pigment. Its original position remains recognizable for quite a long period, and even six months after childbirth appears as a slightly elevated pigmented area.

According to Hinselmann, with whom I agree, the sinuses at the placental site do not undergo thrombosis during pregnancy, but the process becomes inaugurated during the latter portion of second and particularly after the completion of the third stage of labor, although many sinuses never become thrombosed, but are simply compressed by the contracting uterine muscle. The thrombi become organized by the proliferation of the intima of the vessels, and eventually are converted into typical connective tissue.

As the pregnant uterus requires a much more abundant blood supply than the nonpregnant organ, it is apparent that after delivery the lumina of its arteries must undergo a corresponding diminution in caliber. Formerly it was thought that this was brought about by a *compensatory endarteritis,* which disappeared in subsequent pregnancies. Now, however, the prevailing belief is that the larger vessels are completely obliterated by hyaline changes, and that new and smaller vessels develop in their stead. The absorption of the hyaline material is accomplished by processes similar to those observed in the ovaries, although the changes may persist for years, and under the microscope offer a ready means of differentiating between the uteri of women who have, and those who have not, borne children. For details, the student is referred to the articles of Pankow, Goodall, Büttner, and Schwartz.

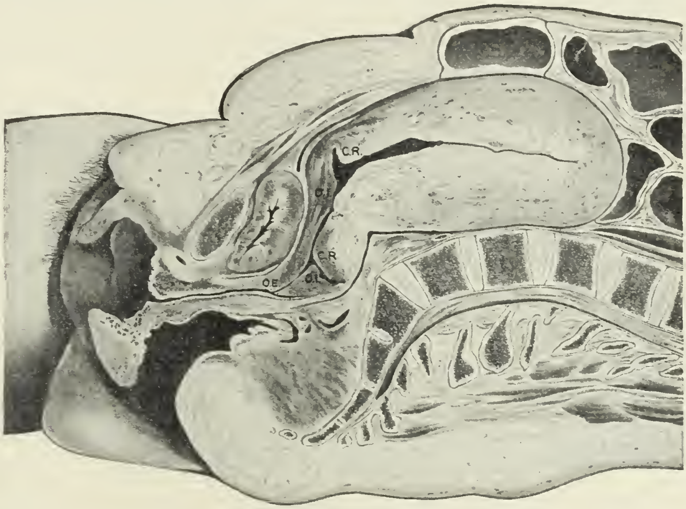

FIG. 341.—FROZEN SECTION JUST AFTER COMPLETION OF THIRD STAGE OF LABOR, SHOWING COLLAPSE OF LOWER UTERINE SEGMENT AND CERVIX (Benckiser).
C.R., contraction ring; *O.E.*, external os; *O.I.*, internal os.

Changes in the Cervix, Vagina, and Vaginal Outlet.—Immediately after the completion of the third stage, the cervix and lower uterine segment are represented by a soft, collapsed, flabby structure, whose boundaries can be made out only with difficulty. The margins of the external os are usually marked by depressions indicating the seat of lacerations. Its opening contracts slowly. For the few days immediately following labor it readily admits two fingers, but by the end of the first week it has become so narrow as to render difficult the introduction of one finger. What remains of the contraction ring comes in contact with the upper portion of the cervical canal, so that in digital examination the lower margin of the former may be mistaken for the internal os (Fig. 341).

Stieve has pointed out that the body of the uterus and the cervix behave diametrically differently during the puerperium, in that the former undergoes involution, whereas in the latter a very considerable new formation of muscle cells occurs.

The vagina requires some time to recover from the distention to which it has been subjected. In the first part of the puerperium it is represented by a capacious, smooth-walled passage, which gradually diminishes in size, though it rarely returns to its virginal condition. The rugæ begin to reappear about the third week. The vaginal outlet is also markedly distended, and in primiparæ usually bears signs of more or less extensive laceration. The hymen, as such, has disappeared, and its place is taken by a number of small tags of tissue, which, as the process of cicatrization goes on, become converted into the *carunculæ myrtiformes,* which are characteristic of the vaginal opening of parous women. The labia majora and minora become flabby and atrophic, as compared with their condition before childbirth.

Changes in the Peritoneum and Abdominal Wall.—While these changes are taking place in the uterus and vagina, the pelvic peritoneum and the structures of the broad ligaments are accommodating themselves to the changed conditions of affairs. For the first few days after labor the peritoneum covering the lower part of the uterus is arranged in folds, which soon disappear. The broad and round ligaments are much more lax than in the nonpregnant condition, and require considerable time to recover from the stretching and loosening to which they have been subjected.

As a result of prolonged distention due to the presence of the enlarged pregnant uterus, the abdominal walls remain soft and flabby for some time. Except for the presence of silvery striæ, they gradually return to their original condition provided the abdominal muscles have retained their tonicity; but when this is much impaired they always remain lax and flabby. In not a few instances, particularly in small women of the hypoplastic type, there may be a marked separation or *diastasis of the recti muscles,* so that a considerable portion of the abdominal contents is covered simply by peritoneum, thinned-out fascia, and skin.

The changes occurring in the breasts are very characteristic, and will be considered in Chapter XVII.

Clinical Aspects of the Puerperium.—*Postpartum Chill.*—Quite frequently the patient may have a more or less violent rigor, coming on shortly after the completion of the third stage of labor. This is a nervous or vasomotor phenomenon, and is without prognostic significance. In this respect it stands in marked contrast to a chill occurring later in the puerperium, which usually indicates the onset of an acute infectious process.

Temperature.—The temperature should remain practically normal during the puerperium; hence any considerable rise should be regarded as abnormal, and considered as a sign of infection until convincing evidence to the contrary can be adduced. Occasionally the temperature may become slightly elevated toward the end or just after the completion of a difficult labor, but rarely goes above 100.4°

F. (38° C.); it usually falls to normal within twelve hours, and does not rise again. A higher temperature during labor usually indicates intrapartum infection, associated with bacterial invasion of the fœtal membranes and the liquor amnii.

Owing to the fact that slight rises of temperature occur frequently during the puerperium without apparent cause, it is customary to designate as normal all puerperia in which the temperature remains below 100.4° F. (38° C.), and as febrile all those in which that limit is reached or exceeded in two different days.

It was formerly believed that the establishment of the lacteal secretion on the third or fourth day of the puerperium was naturally attended by a slight rise in temperature. Indeed, so prevalent was this idea that in pre-antiseptic times the so-called *milk fever* was regarded as a normal phenomenon. At present we no longer believe in the existence of such an entity, and whenever the temperature exceeds the arbitrary normal limit the conscientious obstetrician should fear the beginning of an infection, and begin to search for errors of technic which may have led to it.

Pulse.—During the puerperium the pulse is usually somewhat slower than at other times, averaging between 60 and 70. In nervous women, however, and in those who have had difficult labors or have suffered any considerable loss of blood, a more rapid rate than normal is not infrequent. In a certain number of cases, on the other hand, a day or two after the birth of the child, the pulse becomes unusually slow, and sometimes falls to 50, 40, or even fewer beats to the minute. Fehling has reported a case in which the rate was only 36. Ordinarily this phenomenon is quite transient and the pulse attains its normal rate by the end of the first week or ten days. The slow pulse is usually regarded as a favorable prognostic sign, whereas a rapid heart action, unless it can be accounted for by hemorrhage or cardiac diseases, should be looked upon with suspicion.

This puerperal bradycardia is usually regarded as a characteristic phenomenon. Heil, however, in 1898, stated that he observed it in only 12 per cent of his cases. He affirmed that if the pulse be carefully counted in the same patient for some days before, as well as after, labor, it will usually be found slightly quicker in the puerperium than during pregnancy. Varnier's investigations failed to confirm Heil's conclusions, since they showed that the puerperal slow pulse occurred in 72 per cent of the cases. In a series of patients in my service, reported by Lynch, a slowing of ten or more beats per minute, as compared with pregnancy, was noted in 20.5 per cent, and occurred more than twice as frequently in multiparous as in primiparous women.

Numerous theories have been advanced from time to time in the attempt to explain its mode of production, but none of them is wholly satisfactory. It is not impossible that the solution is quite simple, and may depend upon two factors: the absolute rest in bed, together with the great diminution in work which the heart is called upon to perform after the elimination of the utero-placental circulation. Kehrer attributed the slowing in great part to the lowering of the blood pressure following delivery; Schroeder, to the sudden diminution of the vascular area after the uteroplacental circulation is thrown out of function; Fritsch, to the horizontal position and rest in bed; Löhlein, Novak and Jetter, to stimulation of the vagus or other nervous influences; and Olshausen, to the absorption of various products set free in the blood during the involution of the uterus.

Changes in the Blood.—It is usually stated that there is a slight decrease in the number of red corpuscles and the amount of hemoglobin, attributable to the loss of blood immediately following delivery. Unpublished observations upon the blood volume made in our clinic by Harris, indicate that this statement is incorrect. He has found that the blood volume is increased during pregnancy, giving rise to a relative hydremia, which is associated with a lowered blood count and hemoglobin content. Immediately following labor, however, the blood undergoes an acute concentration, with the result that the cellular constituents, as well as the hemoglobin content, are relatively increased, and afterwards slowly return to the normal nonpregnant proportions.

Hofbauer has directed attention to the occurrence of a leukocytosis occurring during and just after labor. He showed that the leukocytes gradually increase in number from the onset of labor and reach a maximum ten or twelve hours after its conclusion, at which time they are nearly twice as abundant as during pregnancy. Having attained their acme, they promptly fall to normal, rising again slightly on the third or fourth day, with the establishment of the lacteal secretion, after which they remain at the normal level.

After-Pains.—In primiparous women the puerperal uterus remains in a state of tonic contraction and retraction, unless it has been subjected to unusual distention, or blood clots or other foreign bodies have been retained in its cavity, as a consequence of which active contractions occur in the effort to expel them. In multiparous women, on the other hand, the uterus has lost part of its initial tonicity, so that persistent contraction and retraction cannot be maintained, and consequently it contracts and relaxes at intervals, the contractions giving rise to painful sensations, which are known as after-pains, and which occasionally are so severe as to require the administration of a sedative. In many patients these are particularly noticeable when the child is put to the breast, and may last for days, but ordinarily they lose their intensity and become quite bearable after the twenty-four hours immediately following delivery.

Lochia.—During the first part of the puerperium there occurs normally a variable amount of vaginal discharge—the lochia. For the first few days after delivery it consists of blood-stained fluid—*lochia rubra;* after three or four days it becomes paler—*lochia serosa;* and after the tenth day, owing to a marked admixture with leukocytes, it assumes a whitish or yellowish-white color—*lochia alba.* It has a peculiar fleshy odor, suggesting fresh blood. In normal cases the total quantity of lochia varies between 500 and 1000 grams, being less profuse in women who suckle their children. Foul-smelling lochia indicate infection with putrefactive bacteria. In many instances the reddish color is preserved for a longer period, but when it persists for more than two weeks, it indicates the retention of small portions of the after-birth, or imperfect involution, which is frequently associated with retroflexion of the uterus. When examined under the microscope during the first few days, the lochia consist of red blood corpuscles, leukocytes, fatty epithelial cells, shreds of degenerated decidual tissue and bacteria.

Micro-organisms can always be demonstrated in the vaginal lochia, but are not always present when the discharge is obtained from the uterine cavity. The investigations of Döderlein, Krönig, Little, and myself have shown that normally the latter does not contain pathogenic bacteria during the first few days of the puerperium, but that they occur with increasing frequency as it advances.

Harris and Brown, in 1928, studied the uterine lochia obtained on the fifth day from 30 normal puerperal women in our clinic. In 10 the cultures were sterile, while in the other 20 diphtheroids, but no other bacteria, were found. On the other hand, the vaginal lochia always contained bacteria, but, while various types of streptococci were present in 24 women, the aërobic, beta-hemolytic streptococcus, which is the usual cause of puerperal infection, was always absent. Later in the puerperium the vaginal bacteria gain access to the uterine cavity, so that cultures taken much after the fifth day are valueless from a diagnostic or prognostic point of view.

Krönig, as early as 1897, showed that the bacterial flora of the vagina undergoes a marked change during the puerperium, when the bacilli, which had predominated during pregnancy, are in great part replaced by cocci. This change is probably due to the altered reaction of the secretion, which is markedly acid before, and alkaline after, labor. Kessler, who has studied the hydrogen-ion concentration of the vaginal secretion, has found that its P_H falls from 4-5 during pregnancy to 6-7 during the puerperium, and that the normal acidity is not regained until five or six weeks after delivery. It should also be remembered that Noguchi and Kalaki have shown that dark field examination of normal vaginal lochia frequently reveals the presence of spirochetes, similar to those found in the mouth. They are usually of no pathogenic significance, but may possibly lead to serious diagnostic error in the hands of inexperienced persons.

General Functions.—The function of the skin is markedly accentuated, as is demonstrated by the profuse sweating which frequently characterizes this period. It is most marked at night, and it is not unusual for the patient to awake from a sound sleep to find her nightgown drenched with perspiration. It passes off spontaneously and does not require treatment.

The appetite is usually diminished during the first few days after labor, and the patient experiences little desire for nutritious food. At the same time, owing to the marked diaphoresis and the quantity of fluid lost through the lochial discharge, thirst is considerably increased.

The bowels are nearly always constipated during the first part of the puerperium. This is due partly to the fact that the patient eats but little solid food, but principally to the relaxation of the abdominal walls and their consequent inability to aid in evacuating the intestinal contents.

Urine.—There is a marked increase in the urinary output during the puerperium. More important, however, are the changes in the composition of the urine, to which reference was made on page 403, and which afford an index to the profound changes in metabolism which characterize this period.

In the majority of cases the examination of urine, removed by catheterization immediately after the completion of labor, shows a slight amount of albumin and numerous hyaline casts, even though both may have been absent throughout pregnancy. In a series of patients studied in my service by Little, traces of albumin were noted in 89 per cent, and casts in 41 per cent. This is a transient phenomenon resulting from the systemic strain caused by labor, and usually disappears within twenty-four hours, though in a certain number of cases traces of albumin persisted for some days, but always disappeared by the end of the second week, unless the patients were suffering from toxemia or chronic nephritis. It should be remembered that such statements apply only to urine obtained by catherization, as voided specimens always contain albumin so long as the lochia persist.

Occasionally a small amount of sugar may be found in the urine during the first weeks of the puerperium. Careful investigation has shown that the reaction is due to the presence of lactose, or milk sugar, which is supposed to be absorbed from the mammary glands, so that the condition has no connection with diabetes. Ney observed it in 77 per cent of his cases, while McCann and Turner detected it in small quantities in every case which they examined. In my own clinic, the routine weekly urinary examination in 3000 patients showed an incidence of 4.69 per cent. The question will be considered now fully in the section on glycosuria and diabetes in pregnant women.

Couvelaire, and Scholten have demonstrated that there is a marked increase in the amount of acetone in the urine immediately after labor, which disappears within the next three days. The last-named investigator noted it in 94 per cent of his cases, and found that it was most abundant after difficult and prolonged labors. He attributes its production to the excessive breaking-up of carbohydrates resulting from the increased muscular activity incident to parturition.

There is a marked tendency toward retention of the urine during the first few days of the puerperium, and occasionally the distended bladder can be distinguished as a fluctuant tumor above the umbilicus. The retention may result from numerous causes, but is particularly apt to follow operative or difficult labors; and in such circumstances may be attributable to contusions or other slight lesions of the urethra. In other cases it is probably caused by the diminished intra-abdominal pressure, which allows a greater quantity of urine to accumulate in the bladder than under other conditions, as well as by the flaccidity of the abdominal walls and the consequent difficulty of bringing them into play during urination. In not a few cases it is due to the fact that possibly at any time the patient is unable to evacuate the bladder in the recumbent position.

Loss of Weight.—In addition to the loss of 6 to 6½ kilograms, which results from the evacuation of the contents of the uterus, there is generally a still further loss of body weight during the puerperium, which, according to Gassner, amounts to 4500 grams in the first week. Heil estimates it at 2000, and Klemmer at only 900 grams. This apparent contradiction is due to the fact that Gassner's results were obtained at a time when the diet was greatly restricted, but at present, when it is more liberal, the loss of weight is much less, and in many instances does not occur at all if sufficient food be taken. In normal women the loss is nearly always regained by the end of the puerperium.

Care of the Patient during the Puerperium.—*Attention Immediately after Labor.*—After carefully examining the placenta just after its expulsion, to make sure that it is intact, the physician should devote his attention to watching the condition of the uterus. At this time it should form a hard, round, resistant tumor, whose upper margin lies below the umbilicus. As long as it resembles a cricket ball in consistence, there is no danger of postpartum hemorrhage, which becomes imminent if the uterus should grow soft and flabby. To guard against such an occurrence, the uterus should be gently palpated through the abdominal walls immediately after the conclusion of the third stage, and the maneuver repeated at frequent intervals. If it has the consistency of a baseball, it should be let absolutely alone; but if any tendency toward relaxation is detected, the organ should be grasped through the abdominal walls and vigorously kneaded until it remains persistently contracted; at the same time pituitary extract or ergot should be administered hypodermically.

Even in normal cases, the physician should not leave the patient immediately after the completion of labor, but should remain within call for at least one hour, so as to be available should any complication arise. If at the end of that period the uterus remains satisfactorily contracted, the patient can be safely left, but, if it is not, contractions should be stimulated by appropriate measures, and the behavior of the organ carefully watched until the physician feels assured that all danger of hemorrhage has passed. Occasionally, this may necessitate a wait of several hours.

Toilet of the Vulva.—Immediately after the birth of the placenta, the soiled linen having been removed from beneath the patient, the buttocks and external genitalia are bathed with a 1 : 2000 bichloride solution. A sterile vulval pad, made of cotton wrapped in gauze, is then applied over the genitalia and held in place by a "T" bandage, being replaced by a clean one whenever necessary. The number of pads required in the twenty-four hours varies according to the amount of lochial discharge, and affords a fairly accurate means of estimating its quantity. Each time the pads are changed, and after each movement of the bowels, the genitalia should be cleansed with fresh cotton pledgets soaked in bichloride solution, care being taken that the parts are washed from above downward, so as to avoid contamination from the rectum. The use of bichloride solution is not essential, as comparative observations made in my service by E. D. Plass have shown that, even in the presence of perineal tears, equally good results may be obtained by the use of boiled water.

The vulval pad not only absorbs the lochia and prevents contamination of the vulva from without, but also makes it difficult for the patient to touch her genitalia, a practice very common among the uneducated classes, and one that occasionally gives rise to infection.

Binder.—Many authorities recommend that a tightly fitting binder of unbleached muslin, reaching from the trochanters to above the umbilicus, be applied immediately after delivery, since they hold that it exerts a beneficial effect upon the involution of the uterus and the abdominal wall, makes the patient more comfortable, and tends to restore her figure to its original condition. Personally, I do not employ it during the first days of the puerperium, as I am convinced that it has no influence upon the involution of the uterus, nor upon the restoration of the figure. On the other hand, I feel that it may retard the latter by inhibiting the movements of the abdominal wall; as in my experience the tonicity of the abdominal wall is the main factor concerned, and when this is seriously impaired I know of nothing that will bring about the desired result, although massage and systematic gymnastic exercises during the last week the patient spends in bed may do something toward it. If, however, the abdomen is very fat or unusually flabby, a well-fitting bandage adds materially to the comfort of the patient, and should be applied.

After-Pains.—Since after-pains occur in primiparæ only when the uterus has been subjected to undue distention, it is not usually necessary to provide for their relief after the birth of a first child. On the other hand, after the delivery of a multiparous patient, it is advisable to leave with the nurse several tablets of $\frac{1}{6}$ grain of morphine and $\frac{1}{150}$ grain of atropine with instructions to administer them by the mouth at intervals of four or six hours, if the pains be severe.

Rest and Quiet.—As soon as the patient has been made comfortable, the room should be darkened and she should be encouraged to sleep. The relatives should be excluded, and the nurse should bathe and dress the baby in an adjoining apartment, if there is one at her disposal. Following normal delivery, the patient should be kept in bed for ten or twelve days, but should always be permitted to move freely and to sit up to make her toilet and to eat her meals. During the first week, only the immediate members of the family should be admitted to see her. Moreover, if these are numerous, strict instructions should be given the nurse as to the number of visitors each day.

Diet.—Formerly it was the custom to restrict to a minimum the diet of the puerperal woman, and, as has already been said, this limitation goes far to explain the loss of weight which was frequently observed during the first few days. At present, however, a more liberal allowance is customary, and the patient is encouraged to take plenty of plain nourishing food.

If not nauseated, she should be given a glass of milk or a cup of tea soon after labor. For the first few days the appetite is not vigorous, but small quantities of easily digested food may be taken at frequent intervals. I usually give the nurse the following directions: For the first twenty-four hours, water, milk, coffee, tea, or cocoa, boiled or poached eggs, and buttered or soft toast. Following this, however, the ordinary diet should be resumed in accordance with the appetite of the patient, with milk, cocoa, or some other easily assimilable fluid nutriment interspersed between the regular meals.

Temperature.—The temperature should be carefully watched during the first week of the puerperium, as fever is usually the first symptom of the onset of an infectious process. If the patient be in charge of a trained nurse, it should be taken four times daily—at 8 A.M., 12 M., 4 P.M., and 8 P.M., and recorded upon a suitable chart. The physician should be immediately notified if it rises above 100° F. But when the nurse is ignorant the temperature should be taken by the physician himself, morning and evening, for the first five days. This, of course, means that during that time he must visit the patient twice a day, once a day for the following two or three days, and afterward at less frequent intervals. But when the nurse is competent a single daily visit will suffice, unless untoward symptoms develop. It is well, however, whenever possible, that the patient should be seen within the first twelve hours following delivery.

Urination.—The patient should be encouraged to urinate within the first six hours. When she is unable to do so, the catheter should not be employed until the bladder forms a definite tumor above the symphysis, and not even then until the patient has attempted to urinate in a sitting position, inasmuch as many women are unable to use a bed pan. I consider the change in position much less dangerous than catheterization, as the latter, no matter how carefully performed, always carries with it some risk of infection and of a consequent cystitis. Moreover, in not a few cases, the procedure, when once commenced, must be continued for a number of days, a condition of affairs which, leaving out of account the danger of infection, becomes very onerous to the physician, unless he has a competent nurse in charge.

When, however, catheterization becomes necessary, the genitalia having been first exposed and bathed with a bichloride solution, a freshly boiled glass catheter should be introduced by carefully disinfected fingers; or, better still, it should be grasped with a piece of freshly boiled cotton, so as to prevent its coming in contact with the fingers at all. At the present day, to catheterize a woman under a sheet or by the sense of touch is not justifiable. If repeated catheterization becomes necessary, 5-grain tablets of hexamethylenamine should be administered four times daily as a prophylactic measure against cystitis.

Bowels.—In view of the sluggishness of the bowels in the puerperium, a mild cathartic should be administered on the morning of the third day, unless they have previously been evacuated spontaneously. For this purpose I generally employ an ounce of castor oil, or an ounce of Rochelle salts in a small quantity of water.

After the preliminary cathartic, the bowels should be moved once daily.

If a spontaneous action does not occur, the administration of the fluidextract of cascara, at bedtime, in 20- to 60-minim doses, or 1 or 2 drams of the aromatic elixir, according to the susceptibility of the patient, is indicated. Sometimes a pill containing aloin, belladonna and strychnine, or 1 to 2 teaspoonfuls of compound licorice powder, prove more satisfactory.

Care of the Nipples.—Details concerning the care of the nipples will be given in the next chapter, but the physician should be careful to impress upon the nurse the necessity of observing every precaution in dealing with them; and she should be directed to report immediately the appearance of fissures, as their proper treatment will usually prevent mammary infection and the consequent danger of mastitis.

Time for Getting Up.—It is a time-honored custom to allow the puerperal woman to sit up on the tenth day. This rule, however, should not be slavishly followed, and every patient should be kept in bed until the fundus of the uterus has disappeared behind the symphysis pubis. This frequently occurs by the tenth day, occasionally a day or so earlier, but very often not until some days later. Generally speaking, a two weeks' rest in bed is not excessive.

Küstner revived the practice of allowing the patient to get up on the third or fourth day after delivery, and stated that he had seen no ill consequences following it. His suggestion was promulgated before the German Gynecological Congress, in 1899, and has found many followers, especially in Germany. No doubt it is feasible in most cases, but, in general, I do not believe that it subserves the best interests of the patient. It is interesting to note that a similar suggestion was made by Charles White of Manchester as early as 1773, and a century later by Goodell of Philadelphia.

It is also advisable to give strict directions as to the length of time the patient should remain out of bed. I have found it a convenient rule to direct that she should sit up for one hour on the first day, two hours on the second, and to increase the time by an hour each day until she is able to be up all the time. She should be kept in her room until the expiration of the third week, and allowed to move about on the floor on which she was confined during the fourth week, being forbidden to go downstairs until the expiration of this period, as it is a matter of experience that the average woman cannot be prevented from assuming the ordinary duties of her household after she has once gone downstairs. In hospital practice, normal ward patients are usually discharged by the end of the second week and immediately assume their household duties. Private patients who live in the city in which the hospital is located, may be discharged at the same time, but they should be cautioned to spare themselves for the following two weeks, as indicated above. On the other hand, those who must travel any considerable distance to return to their homes, should remain in the hospital for a longer period.

Reappearance of Menstruation.—If for any reason the woman does not suckle her child, the menstrual flow will probably return within eight weeks after labor. On the other hand, it is generally believed that the flow ordinarily does not appear so long as the child is suckled, or at least not until it is nearly a year old. In my experience, the greatest possible variations are observed in this respect, as in lactating women the first period may occur as early as the second or as late as the eighteenth month following delivery, with the most usual time between the fifth and sixth months. It is, likewise, generally believed that ovulation does not occur during lactation, and many women suckle their children for long periods in the hope of avoiding conception. That the belief is not justified is shown by the fact that not a few women conceive in such circumstances. Pinard stated that from 40 to 73 per cent of his patients menstruated within six months after the birth of the child, and that the function becomes reëstablished later in multiparous than in primiparous women. Ehrenfest, in 1915, stated that 51.3 per cent of his patients menstruated within three months and 71 per cent within six months after delivery; while in 80 per cent menstruation occurred before the cessation of lactation.

Final Examination.—At the end of the third or the beginning of the fourth week the patient should be subjected to an internal examination, when the condition of the perineum, uterus, and appendages should be carefully investigated. In approximately one-third of all patients—Lynch states 41 per cent—the uterus will be found displaced backwards. Its replacement and the introduction of a properly fitting pessary may lead to a prompt cure; whereas if the treatment be deferred until symptoms appear, the condition may not be relieved so readily. In other cases, various abnormalities may be noted, which should be treated before the patient is discharged, and occasionally it may be necessary to warn her that operative procedures will be required in the future. If everything is perfectly normal, it is a great comfort to the patient to be assured of the fact; whereas if any abnormality is noted and the attention of some responsible member of the family be directed to it, the physician may save himself from censure if a subsequent examination be made by someone else.

Even though everything is found in order at this examination, it is a wise precaution to encourage the patient to return for reëxamination six months or one year later. In this event, abnormalities, which may have originated in the meantime, can be recognized and, if necessary, corrected, while the visit affords the physician an opportunity to observe the general effect of childbearing upon his patient, as well as to ascertain what influence it has exerted upon any complication from which she may have suffered during pregnancy or labor. For a number of years, I have insisted upon such a yearly return in the case of our ward patients, and I am convinced that the results obtained have amply repaid both the patients and the members of the staff for the time and trouble taken.

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CHAPTER XVII

THE NEWLY BORN CHILD

In this chapter will be considered only those conditions which are of direct practical interest to the obstetrician, who is referred to the standard works upon pediatrics for information concerning the special physiology and pathology of the infant.

Normally, the newly born child begins to cry almost immediately after its exit from the vulva. This act indicates the establishment of respiration, which is accompanied by important modifications in the circulatory system. The mode of production of the first breath has given rise to much speculation. Among the many hypotheses that of Warnekros deserves consideration. In his x-ray studies of the process of labor, he noted an almost conical compression of the thorax during the second stage, and suggested that the expansion which must inevitably follow the delivery of the shoulders would afford a plausible explanation for the first inspiratory movement.

Circulatory Changes.—As soon as the lungs begin to function, the blood which is brought by the inferior vena cava to the right auricle no longer passes through the foramen ovale, but makes its way directly through the right ventricle, whence it is carried to the lungs by means of the pulmonary arteries. Coincident with the establishment of the pulmonary circulation, there ensues a marked increase in the pressure in the left auricle. This in turn brings about the closure of the valve of the foramen ovale, which after a few months fuses with the periphery of the opening. At the same time the blood ceases to flow through the ductus Botalli into the aorta, and the canal itself gradually becomes obliterated. According to Strassmann, the primary cause for this change is to be found in the fact that the ductus traverses the wall of the aorta in an oblique direction, so that, as soon as the pressure in the aortic arch is increased, its wall acts as a valve and in this way occludes the distal end.

The circulation through the umbilical arteries normally ceases in from five to fifteen minutes after birth, pulsation disappearing first at the maternal end of the cord. This is brought about by the contraction of the thick muscular walls, which practically obliterate the lumina of the arteries. It is usually stated that after the establishment of the pulmonary circulation the general arterial pressure is diminished to such an extent that it is insufficient to force the blood through them. The investigations of Ahlfeld have shown that this is not the case, and would rather indicate that the contraction of the arteries is brought about by the stimulation resulting from the cooling of the cord immediately after birth. That this explanation is correct is demonstrated by the fact that the circulation can be reëstablished by immersing the child in a warm bath.

This point is of practical importance in view of the fact that occasionally, when the cord has not been ligated sufficiently tightly, secondary hemorrhage occurs from its fœtal end after the child has been placed in a warm bed. To guard against such an occurrence the cord should be reinspected before the physician leaves the patient.

The child passes urine almost immediately after birth, and frequently while in the act of being born. In a considerable number of cases a certain amount of meconium is also discharged. As a result of the cooling of the surface of the child on coming into the world, its temperature becomes reduced by a few degrees, which, however, are promptly regained after it has been bathed and placed in a warm bed. For the first few days of life the temperature is in very unstable equilibrium, and a very slight cause may give rise to a considerable elevation.

Care of the Umbilical Cord.—As has already been said, the umbilical cord should not be ligated until it has ceased to pulsate, unless there is some reason to the contrary. Two ligatures of sterilized bobbin should be placed about it and tightly tied, one about 2 centimeters from the surface of the abdomen, and the other about the same distance beyond the first, the cord being then cut between them with a pair of sterile scissors.

Owing to the absence of circulation, what is left of the cord undergoes a process of mummification. Within twenty-four hours it loses its characteristic bluish-white, moist appearance, and soon becomes dry and almost black. Gradually a line of demarcation appears just beyond the skin surface of the abdomen, until in a few days the stump sloughs off, leaving behind a small, granulating wound, which, after healing, forms the umbilicus.

This separation usually takes place within the first ten days after birth, but it is not unusual for it to require a longer time, and occasionally several weeks may elapse before it occurs. In the very rare instances in which the stump is still adherent at the end of the puerperium, it may become necessary to clip it off with a pair of scissors.

Formerly the care of the cord was considered a very trivial matter, and the midwife, as a rule, would wrap it in a piece of greased or singed linen, after which little or no attention was paid to it. This practice, however, and the total neglect of aseptic precautions frequently resulted in an infection which was transmitted through the umbilical vessels, so that in times past large numbers of children perished from so-called "puerperal fever," as well as from tetanus neonatorum. Even now, when the necessity for proper treatment is generally recognized, umbilical infections are not unknown.

Attention was redirected to such conditions by Eröss, in 1891, who stated that a great part of the rises in temperature occurring in young infants is due to umbilical infections. Keller, after studying the vital statistics of Berlin for the years 1904 and 1905, concluded that at least 20 per cent of all deaths during the first weeks of life were due to this cause.

Usually these umbilical infections indicate gross lack of care, but occasionally they occur in spite of every precaution. Thus, within one week four babies in my service died from general streptococcus peritonitis, due to an infectious process in the umbilical vessels. This epidemic occurred at a time when especial interest was being taken in the care of the cord, and when not a single case of puerperal infection had been in the ward for weeks, so that the only cause which could be discovered for it was an infected finger in the mother of one of the children. As the umbilical stump in these cases presented no outward sign of infection, the conditions would have escaped detection had autopsy not been performed. Accordingly, it may be stated as a safe general rule that, whenever children die without any appreciable cause within two weeks after birth, such an infection should be suspected, and, if an autopsy is performed, examination of the intra-abdominal portion of the umbilical vessels will frequently show that they are filled with purulent thrombi, in which pyogenic micro-organisms can be demonstrated. In view, therefore, of the not inconsiderable danger of infection from this source, strict aseptic precautions should be observed in caring for the cord. The reader is referred to Ploss's work for interesting details concerning its treatment in various countries and by aboriginal peoples.

After making the mother comfortable, the nurse should devote her attention to the child, but in hospital practice it is advantageously cared for while waiting for the separation of the placenta. This serves a double purpose, in that it enables the various procedures to be carried out under an aseptic technic, and tends to prevent the obstetrician from being tempted to resort too early to expression of the placenta. The vernix caseosa is best removed by sterile gauze sponges soaked in albolene, following which a bath is not necessary. If the cord was cut between two clamps, a ligature is now applied to its fœtal end, the clamp removed and the stump wrapped in a strip of sterile gauze soaked in 95 per cent alcohol, after which the abdominal binder is applied.

This method of treating the cord, which was first recommended by Budberg, I have used since 1906 with very satisfactory results. The original dressing remains in place until it becomes soiled or until the stump has separated, though it is well to moisten it with alcohol from time to time. After the cord has sloughed off, the granulating umbilicus should be covered by a sterile dressing, and the child should not receive a full bath until it has completely healed. During this period it should be bathed in the lap of the nurse, care being taken not to contaminate the umbilical dressings. Keiffer considers that the vernix caseosa represents a secretion from the amniotic epithelium, and is absorbed by the skin of the child. For this reason he recommends that it be not removed, as he believes that it has a nutritional function and tends to diminish the initial loss of weight. I, however, have not had sufficient courage to test his recommendation.

W. M. Dabney, while an assistant in my service, made comparative observations in the hope of determining the best method of dealing with the cord. He treated several series of cases, respectively, with the following dressings: Boric acid, salicylic acid, a mixture of salicylic acid and starch, and a wrapping of silver foil. So far as he could see, it made no difference which dressing was employed, it being safe to use any one of them, provided a proper technic is followed. In still another series of cases he applied an occlusive dressing of liquid celloidin, but found that in such circumstances the cord was kept unduly moist, and separation was perceptibly delayed.

The question as to the proper method of treating the cord has given rise to a great deal of discussion. Dickinson, in 1899, in a paper entitled "Is the Sloughing Process at the Child's Navel Consistent with Asepsis in Child-bed?", answered the question in the negative, and in 1916 reaffirmed his belief. He recommended that the cord be completely excised where it joins the abdomen, its vessels ligated, and the wound closed by sutures. Possibly this may be the ideal method of treatment, but it is a question whether it is advisable in private practice, as it is probable that, should the child die within a few weeks after such a procedure, the physician would be severely criticized by members of the family who have become accustomed to the time-honored treatment.

From time to time various methods have been recommended in place of the time-honored ligature—such as cutting the cord with red hot scissors, compressing it by powerful forceps, as in angiotripsy, the use of specially devised metallic clamps or of Ziegler's ingenious rubber device. I have tried many of them, but soon return to the method just described. On the other hand, Rachmanow believes that all such precautions are useless, and reported that in 9000 out of 10,000 consecutive children delivered under his care he had simply cut the cord, after it had ceased to pulsate, and in not a single instance did serious hemorrhage occur, notwithstanding the fact that no ligatures were used. Such results, however, are contrary to my experience, as I have repeatedly observed profuse hemorrhage after the cord had been carefully ligated.

Care of the Eyes.—In view of the frequency with which the eyes of the newly born child become infected when passing through the birth canal of women suffering from gonorrhea, Credé in 1884 introduced the practice of instilling into each eye immediately after birth one drop of a 1 per cent solution of silver nitrate, which was afterward washed out with salt solution. This procedure has led to a marked decrease in the frequency of gonorrheal ophthalmia and the cases of blindness resulting from it, and should be followed as a matter of routine as soon as the cord is cared for. Even with private patients, I habitually employ Credé's method, as the development of ophthalmia in several babies treated with boric acid solution has taught me that gonorrhea may be present where least suspected.

An especial technic should be employed in the instillation of the silver nitrate solution, for if the eyelids be widely opened and the solution dropped directly upon the cornea, irreparable injury may be done, especially in premature infants. William H. Wilmer recommends the following technic, which we employ routinely in our service. As a preliminary precaution the region about each eye should be irrigated with a 1 :10,000 solution of mercuric chloride or iodide. This should be applied to the side of the eye nearest the nose and allowed to run off from the opposite side. Then, the lower lid should be drawn down and the silver solution dropped into the lower culdesac, whence in the course of two minutes it diffuses itself over the entire conjunctiva. At the expiration of that time the lids should be held apart and the conjunctival sac freely flushed with warm normal salt solution by means of a rubber eye syringe. This serves the double purpose of washing out the excess of silver nitrate, and of forming an insoluble compound with any fraction of it which by chance should be retained.

The prophylactic value of silver nitrate was strikingly demonstrated by Haab, whose statistics showed that its employment in hospital practice had reduced the frequency of opththalmia neonatorum from 9 to 1 per cent, while the statistics from many hospitals show an incidence of only 0.2 to 0.1 per cent. If, however, the disease should appear in spite of the precautions taken, it should be promptly and vigorously treated, inasmuch as when neglected it almost invariably leads to clouding of the cornea and often to complete blindness. Cohn estimated, in 1876, that 30 per cent of the patients in the blind asylums of Germany, Austria, Holland, and Switzerland owed their trouble to ophthalmia neonatorum. Twenty years later these figures had become reduced to 19 per cent; while Credé-Hörder, in 1912, reported a further diminution to 12.39 per cent. J. J. Carroll stated that 30 per cent of the inmates of the Maryland School for the Blind, in 1909, owed their blindness to the same cause, and that its incidence had increased rather than decreased during the previous twenty years. This means that our results are much worse than in Germany, and that the average practitioner and midwife have failed to appreciate the prophylactic value of Credé's method, and makes pertinent the inquiry as to the advisability of legislation compelling the use of silver nitrate in all cases.

In very rare instances the gonorrheal process may be thoroughly established at the time of birth—the so-called intra-uterine ophthalmia. In such cases the infection develops while the child is still *in utero,* and Stephenson states that it may even occur without premature rupture of the membranes, having been noted in children born in a "caul."

Zweifel, in 1900, advocated substituting a 1 per cent solution of silver acetate for the nitrate, and reports that, in a series of 5222 children so treated, ophthalmia was observed in only 0.23 of 1 per cent. The employment of protargol, argyrol, sophol, and various other preparations of silver has been suggested, but experience has shown that they give no better results than silver nitrate. Care should be taken that only fresh solutions are employed, as they rapidly deteriorate on keeping, especially when exposed to the light.

Stools and Urine.—For the first few days after birth the intestinal contents are represented by a brownish or brownish-green, soft material—the meconium. It is made up of cast-off epithelial cells from various portions of the intestinal tract, a few epidermal cells and lanugo hairs which have been swallowed with the amniotic fluid. Its peculiar color is due to the presence of bile pigments. During pregnancy and for a few hours after birth the intestinal contents are sterile, but bacteria soon gain access to them and are afterward present throughout life.

After the third or fourth day, with the establishment of the mammary secretion, the meconium disappears, and its place is taken by feces, which are light yellow in color, homogenous in consistence, and possess a characteristic odor. For the first few days the stools are not formed, but after a short time they take on the characteristic cylindrical shape. The bowels, as a rule, move twice daily, but a single large dejection is sufficient.

If the child is not gaining weight satisfactorily, the physician should make it a rule to inspect the stools at each visit, and instruct the nurse to save a napkin in anticipation of his arrival, as in this way important information may be gained concerning certain disturbances of the digestive process.

The physician should impress upon mother and nurse the necessity of attempting to train the child to regular habits as to urination and defecation, and it is surprising how soon these may be formed if proper care is taken. For this purpose, the napkins should be changed before each feeding, and after the first few weeks the child should be held over a small chamber at these times. It should also be encouraged to defecate at regular intervals. To accomplish this, it should be laid upon the bed at the same hour each day with a napkin under its buttocks, and its abdomen stroked along the course of the colon.

Icterus.—Not infrequently on the third or fourth day after birth, the skin and conjunctivæ of the child take on a yellowish hue, which may vary from a scarcely visible discoloration to an intense jaundice. It occurs in 15 to 80 per cent of all mature children, according to various writers, and is almost universal in premature children. Ordinarily, it has no clinical significance and passes off in a few days without treatment.

According to Hofmeier, the condition is hematogenous in origin, and is due to the breaking down of large numbers of red corpuscles soon after birth. Following the researches of Ylppö, much work has been done upon the subject, and the literature was well reviewed by Hannes, in 1924, and by Marabotto, in 1927. All recent investigators agree that the blood of the newly born child shows an increased bilirubin content, which tends to decrease within a few days after birth, but that jaundice develops when its amount is excessive. Three main views have developed as to its origin. Many authors hold that it is entirely hepatogenous, and is due to the fact that the liver has not fully assumed its postnatal functions. Others consider that it is both hepatogenous and hematogenous, while a smaller group connects it with changes in the placenta itself. To my mind, the evidence in favor of the latter view is not convincing, and it remains for future investigators to demonstrate which of the first two is correct.

Initial Loss of Weight.—Owing to the fact that the child receives little or no nutriment for the first three or four days of life, and at the same time casts off considerable quantities of urine, feces, and sweat, it progressively loses weight until the milk flow becomes established, the total loss averaging 250 grams (8 ounces). If the child is nourished properly, this is usually regained by the end of the tenth day, after which the weight should increase steadily at the rate of about 25 grams (6 drams) a day for the first few months, so that it becomes doubled by the time the child is five months of age.

The initial loss is usually much greater when the child is excessively large, as well as in premature infants and those who receive an insufficient supply of food.

Anatomy of the Breasts and Lactation.—Each breast is made up of from 15 to 24 lobes, which are arranged more or less radially, and separated from one another by a varying amount of fat, to which the size and shape of the organ is in great part due. Each lobe consists of several lobules, which in turn are made up of large numbers of acini. These last are composed of a single layer of epithelium, beneath which is a small amount of connective tissue richly supplied with capillaries. Every lobule is provided with a small duct, which, meeting others, unites to form a single larger canal for each lobe. These so-called *lactiferous ducts* make their way to the nipple and open separately upon its surface, where they may be distinguished as minute isolated orifices.

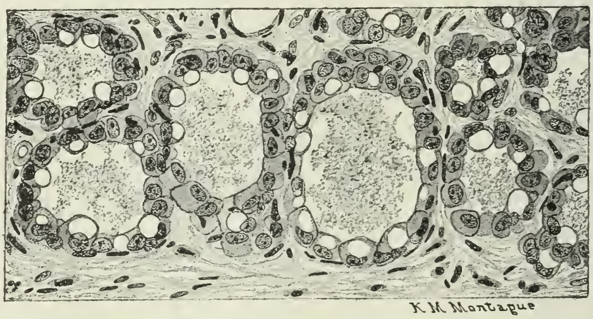

Fig. 342.—Lactating Breast (Zeiss, DD-4).

The acini represent the functioning portion of the breasts, and it is from their epithelium that the various constituents of the milk are formed. This fact was first demonstrated by Heidenhain.

We have already referred to the changes occurring in the breasts during pregnancy, and their condition remains much the same for the first two days after labor. At this time they do not contain milk, but a small amount of *colostrum* can be expressed from the nipples. This is a thin, yellowish fluid, which owes its color to the presence of a pigment which is soluble in ether and, according to Kühne, is analogous to the coloring matter contained in the cells of the corpus luteum.

When examined under the microscope, colostrum is seen to consist of a fluid in which are suspended numerous round bodies, 0.001 to 0.025 millimeter in diameter—the so-called *colostrum corpuscles*—which represent cast-off epithelial cells which have undergone fatty degeneration. The fluid portion is a transudate which consists in great part of serum albumin and coagulates on heating. Colostrum contains more proteid material and salts, but less fat, than normal milk; while its sugar content is about the same.

It is generally stated that it possesses but slight nutritive properties and that its chief function is to act as a mild cathartic. Jaschke and Ludwig, on the contrary, hold that children receiving it in considerable quantities suffer a much slighter initial loss of weight than usual. They also believe that the serum albumin which it contains is taken up without change by the epithelium of the digestive tract. Lewis and Wells consider that its chief value consists in its euglobulin content, which can pass directly into the blood and apparently carries with it certain protective antibodies in which the child is deficient. For this reason they hold that it is desirable for the newborn to receive its full ration of colostrum, whereby its immunity to various infections is increased. Doubtless, this may be correct in ruminants in which the structure of the cotyledonary placenta makes unlikely the transmission of such substances from mother to child, but it would appear improbable in man where the conditions for intrauterine transmission are much more favorable.

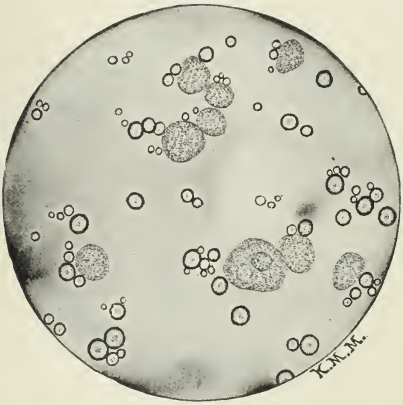

Fig. 343.—Human Colostrum (Zeiss, DD-4).

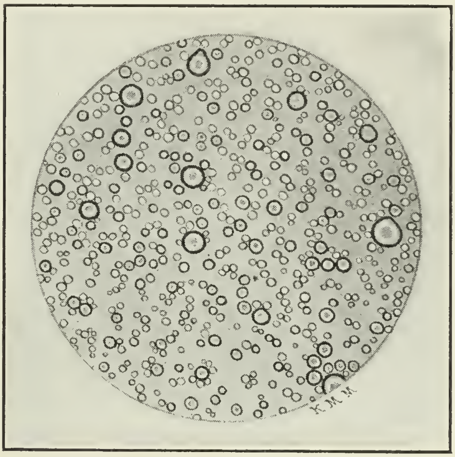

Fig. 344.—Human Milk (Zeiss, DD-4).

Milk.—On the third or fourth day after labor and occasionally on the second, the breasts suddenly become larger, firmer, and more painful. This indicates the establishment of the lacteal secretion, and on pressure a small amount of bluish-white fluid—the *milk*—will exude from the nipples. Coincident with these changes, the patient experiences more or less lassitude, and may suffer from headache. At the same time she has throbbing pains in the breasts, which may extend into the axillæ, and the pulse becomes slightly accelerated. There is rarely any elevation of temperature. It was formerly believed that the establishment of the milk flow was associated with marked constitutional disturbances, which were regarded as manifestations of the so-called *"milk fever."* As has already been said this is very exceptional, and usually a rise of temperature at this time is indicative of infection.

Mother's milk is usually bluish-white in color, though it sometimes has a yellowish tinge. It is slightly alkaline in reaction, and has a specific gravity of from 1.028 to 1.034. Under the microscope it appears as a clear fluid in which are suspended large numbers of small round bodies, 0.008 millimeter in diameter —the so-called *milk corpuscles*. These consist of minute drops of fat surrounded by a membrane. Chemical examination shows that they are made up of the triglycerides of olein, palmitin, and stearin. The fluid portion of the milk is a transudate, and consists of protein material, milk sugar, salts, and water. Milk, therefore, represents an emulsion of fine fat droplets in a fluid medium.

The protein material in milk serum consists of one-third casein and two-thirds lactalbumin, which are direct metabolic products of the mammary epithelium, and differ from serum albumin in that they do not coagulate on heating. The fat and lactose, or milk sugar, are also products of the epithelial cells. The milk serum contains a considerable amount of mineral matter, one-half of which, according to the investigations of Holt, consists of calcium phosphate and potassium carbonate, while the remainder is made up of sodium chloride, potassium chloride, potassium sulphate, magnesium carbonate, and minute quantities of several other salts, including iron.

The average composition of milk is as follows: Proteids, 1 to 2 per cent; fats, 3 to 4 per cent; sugar, 6 to 7 per cent; salts, 0.1 to 0.2 per cent, the rest being water. According to Holt, the average composition of 17 twenty-four hour specimens of mature milk was as follows: Proteids, 1.15; fat, 3.26; sugar, 7.5, and ash, 0.206 per cent, respectively; while in the so-called transitional period —from the end of the first to the fourth week—the proteid and fat content is considerably greater—1.56 and 4.37 per cent, respectively. Milk also contains a not inconsiderable number of bacteria, which, according to the researches of Köstlin, are derived from the terminal ends of the lactiferous ducts and the surface of the nipples; it is questionable whether they are present in the deeper portions of the breast.

Nutritious mother's milk varies markedly in its composition, not only in different individuals, but also in the same individual at various times. It is not unusual to find that the milk of one woman, which agrees perfectly with her own child, will prove indigestible when given to the healthy child of another woman. The variation in the composition of the milk of the same woman at different times is dependent upon various factors, principally the diet, the amount of exercise, and the mental condition. The quantity of milk varies to a large extent with the amount of fluid ingested by the patient, and a diet rich in cow's milk conduces to increased mammary activity.

There are large numbers of preparations in the market which are known as *galactagogues*, and are vaunted as increasing the amount of milk; but whatever virtue they may possess is due in great part to the quantity of fluid taken with them. Exercise in the open air also increases the milk flow, and it is frequently observed that a woman who has but a small quantity, so long as she is confined to her room, will secrete an abundant supply as soon as she begins to take outdoor exercise.

The quality of the milk is likewise dependent in great part upon the food taken by the mother. It is a matter of experience that a diet rich in proteids increases the ratio of the fats, while excessive exercise diminishes the amount of protein material. Marked alterations in the quality and quantity of protein frequently result from nervous and mental influences, and it is not unusual for some profound emotion to lead to almost complete suppression of the lacteal secretion, or to so change its quality as to render it temporarily unfit for the use of the infant. Certain drugs also exert a marked influence upon the milk flow, and it is well known that the use of belladonna or atropine markedly diminishes it. Many substances ingested by the mother may be transmitted through the milk, and thus exert their physiological influence upon the child. This is particularly true of the various cathartics and alcoholic liquors.

It is generally believed that the occurrence of menstruation, or the onset of another pregnancy during lactation, exerts a very deleterious effect upon the quality of the milk, in some cases rendering it necessary to wean the child. When it is remembered how large a proportion of women menstruate while suckling, and how often the first indication of the occurrence of pregnancy in a nursing mother consists in the perception of fœtal movements, it is apparent that the deleterious effect of such occurrences is overestimated.

Nursing.—The ideal food for the newly born child is the milk of its mother, and, unless lactation be contra-indicated by some physical defect, it is the physician's duty to insist that every woman should at least attempt to suckle her child. In many instances where the supply of milk at first appears insufficient, it becomes increased in amount if suckling be persisted in. The act itself also exerts a beneficial influence upon the involution of the uterus, as it is well known that the repeated irritation of the nipples results in reflex stimulation of the uterus, and Temesváry has further proved by actual measurement that involution occurs more rapidly in nursing women. This fact should be urged upon those who are unwilling to nurse their children, and it frequently happens that, although they may have commenced it from selfish motives, they will continue it as long as is necessary.

Unless it be otherwise arranged, the physician who conducts the labor should hold himself responsible for the well-being of the child during the first few weeks of its life, and should not limit his attentions to the mother. He should accordingly give minute directions as to the way in which it should be fed, and see that they are accurately carried out.

Frequency of Feeding.—As the nutritive properties of colostrum are very limited, the child should be put to the breast only three times a day until the milk flow becomes established, but after that time it should be fed at intervals of three or four hours. Definite hours should be set for each feeding, and, if necessary, the child should be awakened from a sound sleep at stated times to take its nourishment, for only by this means can its habits be made regular. I do not consider that a nurse has fulfilled her whole duty unless she leaves the patient with a child properly trained in the matter of taking its food.

Experience has shown that most infants thrive best when fed at intervals of three or four hours, and upon a definite schedule. This is best arranged with reference to the daily bath, so that if it be given a little before 10 A.M., the first feeding would come at 6 A.M., with the evening feeding at the parent's bedtime, and a single one during the night. By this arrangement six feedings will be given each day, which can frequently be reduced to five, as many children can be trained to sleep the entire night without awakening. This, however, can only be accomplished by feeding it at regular intervals during the day, so as to insure that it receives the proper amount of nutriment in the twenty-four hours.

Just before each feeding the napkin should be changed and the child encouraged to urinate, but as soon as it is taken from the breast it should be placed in bed and not disturbed. It should not be allowed to sleep at its mother's breast, nor should it be rocked or fondled after feeding. If these regulations be persisted in, the child will usually go to sleep within a few minutes after being put to bed, and if it wakes before the next feeding is due it will remain quiet. The importance of following these directions cannot be overestimated, for it is only by rigid adherence to such details that the child can be given regular habits, and its care prevented from becoming a strain upon all concerned.

After the fifth or sixth week, one of the breast feedings may be replaced by a bottle, even though the milk supply is adequate. By so doing the tedium of nursing is greatly reduced, and many a woman is willing to suckle a child which she would otherwise wean. When a mother is obliged to return home every few hours to nurse her child, it is apparent that her time is so broken in upon as to render it impossible for her to obtain any real relaxation; whereas if a single bottle be interpolated between any two feedings a long free space will be afforded.

Duration of Feeding.—Definite rules cannot be given concerning the proper length of each feeding, as this point is dependent upon several factors—the quantity of milk, the readiness with which it can be obtained from the breast, and the avidity with which the child nurses. Generally speaking, it is advisable to allow the child to remain at the breast for ten minutes at first, and to lengthen or decrease the time according to circumstances, four or five minutes being sufficient for some children, while fifteen or twenty minutes will be required by others. The tendency toward overfeeding is so universal that it is better at first to err in giving too little rather than too much milk. Crying is not always a symptom of hunger, but much more frequently indicates indigestion, resulting from an overloaded stomach. A child which is receiving the proper amount of nourishment should not spit up its food, should increase steadily in weight, and should have normal yellow homogeneous passages. The occurrence of regurgitation, or the presence of curds in the stools, is a sure sign that it is being nursed too long. On the other hand, loss of weight, associated with normal stools and the absence of regurgitation, indicates insufficient feeding.

In the hospital, the child should be weighed daily, but only once a week at home; as minor variations in the weight curve may be the cause of great unhappiness to the untrained mother. As has already been said, the child should regain its birth weight by the end of the tenth day, and from then on it should gain approximately 25 grams a day, or, roughly speaking, 5 ounces a week. After the first few months the increase is more gradual, the average child doubling its weight at the fifth and trebling it at the fifteenth month.

Care of the Breasts.—Before and after each feeding the nipples should be carefully washed with a boric acid solution, so as to avoid the possibility of bacteria being ground into them during suckling. In many cases, particularly if preliminary precautions have not been taken to prepare them, the nipples become very sore during the first few days of nursing, and little cracks or fissures appear upon them. These are extremely painful to the mother, and in some cases render the act of suckling agonizing. In addition to the suffering which they cause, they are also a source of considerable danger, as it is through them that bacteria gain access to the interior of the breast. The nurse should therefore be instructed to be on the lookout for them, and to notify the physician of their appearance, as prompt treatment will usually lead to their speedy cure. On the other hand, neglect of these premonitory signs is sometimes followed by a mammary abscess, for the occurrence of which the physician and nurse are usually more or less justly blamed.

The fact that large numbers of remedies are recommended for the cure of fissured nipples is abundant evidence that they are not always readily relieved. They are best treated by rest, and if the infant could be kept from the breast for twenty-four hours they would heal without further treatment. As this is out of the question, some other means of securing rest must be adopted, and this is best attained by the use of a so-called English nipple shield, or one of the curved variety devised by Slemons. Many women claim that they are unable to use such a contrivance, but the difficulty is usually due to the fact that the holes in the rubber nipple are too small, and if they are enlarged by passing a red-hot hairpin through them a quantity of milk sufficient for the child can usually be obtained without much difficulty. The application of compound tincture of benzoin, or of a paste composed of castor oil and subnitrate of bismuth, to the fissures tends to hasten the healing, and in the intervals between the feedings the nipples should be covered by compresses soaked with boric acid solution. Particular attention should be devoted to the care of the shield, which should be boiled daily, and carefully washed after each feeding and kept in a vessel containing a saturated solution of boric acid.

In rare cases, the nipples may be so depressed below the surface of the breast as to render nursing out of the question. In such circumstances, unless the use of an electric breast pump brings prompt relief, prolonged attempts at nursing are useless, and steps should be promptly taken to arrest the mammary secretion.

It was formerly taught that the child's mouth should be scrupulously cleansed before each feeding by washing it out with a clean piece of gauze dipped in boric acid solution, with the idea of diminishing the possibility of breast infection. Although it is known that bacteria are constantly present in the buccal cavity of infants, experience has shown that the practice is useless, as it has no effect upon the incidence of mammary infection, and has the disadvantage that it sometimes leads to infection of the child's mouth.

When the child dies, or if for any reason the physician feels that lactation is contra-indicated, steps should be taken to check lactation, or, as it is usually designated, "to dry up the breasts." Formerly this was accomplished by a tedious and laborious process, which consisted in tightly bandaging the breasts, after having covered them with belladonna ointment. Within a few hours they became very engorged and painful, when the excess of milk was drawn off by means of a breast pump, after which the bandage was reapplied, and the process repeated as frequently as necessary, days or weeks often elapsing before the secretion was checked. The treatment was sometimes so painful that the patient complained that it was far worse than the labor itself.

Years ago, E. R. Lewis, of Westerly, R. I., told me that better results could be obtained in less time by the administration of 20 grains of potassium acetate every four hours. My investigations, however, have shown that the drug is without effect, and that Nature will take care of the entire process, if not aggravated by improper treatment.

Since 1905, my practice has been to leave the breasts absolutely alone, except for the application of ice-bags if necessary. Within twenty-four hours after the last nursing, or on the third day, if the child has not been suckled, the breasts become engorged, and sometimes very painful. But if they are not touched, the swelling soon subsides, and the pain disappears within a few hours, after which the breasts gradually become smaller, and contain less and less milk, so that the entire process is over by the end of the third day. If the patient is nervous a placebo may be administered, or if the pain is severe a single hypodermic injection of morphia may be required, but further medication is not necessary. When the breasts are large and pendulous, they may be supported by a bandage, which, however, should not be sufficiently tight to exert pressure. It would accordingly appear that the methods formerly in vogue, and particularly the use of the breast pump and massage, defeated the very purpose for which they were employed, and really served to stimulate the secretion of milk and to subject the patient to unnecessary discomfort.

My experience with this method, both in hospital and private practice, has been so satisfactory that I can strongly recommend its adoption. Those who are interested in details concerning it are referred to the article by my former assistant, Henry J. Storrs.

Artificial Feeding.—When the supply of mother's milk is defective, or when abnormalities of the nipples or constitutional disease render nursing inadvisable, artificial feeding must be resorted to. Numerous so-called infant foods are advertised for this purpose, but most of them are very defective, so that for practical purposes *cow's milk* in some form is the only available substitute for the mother's milk. Unfortunately, however, it differs markedly from the latter in composition, and under the most favorable circumstances is only an imperfect substitute for it. It is usually slightly acid in reaction, and has a specific gravity of 1.029 to 1.033. Its average composition is: Proteids, 4 per cent; fats, 4 per cent; sugar, 4.5 per cent, and salts, 0.7 per cent. It is apparent, therefore, that it contains less fat and sugar, and more protein material and salts, than mother's milk, and consequently cannot be used in its natural form, but must first be modified in some way.

If the child is healthy, satisfactory results are frequently obtained by diluting cow's milk with various proportions of water and adding sugar. Such preparations contain approximately the normal amount of proteid material and sugar, but are lacking in fat. In hot weather the mixture should be pasteurized, but in cool weather this procedure is unnecessary.

The space at our disposal is too limited to permit consideration of the many and complicated problems connected with artificial feeding, and the reader is referred to the various treatises upon pediatrics for extended information. There are, nevertheless, two points upon which I must insist—namely, the capacity of the stomach and the necessity for training the child to regular habits, no matter what method of feeding is employed. It should be remembered that the stomach of the newly born child is very small, and that one ounce will fill it to repletion. That amount of fluid, therefore, should not be exceeded for the first few days, after which it should be increased gradually. The instructions as to the frequency and manner of feeding, which have already been given, apply equally well whether the child is fed at the breast or from the bottle, and too great stress cannot be laid upon their rigid observance.

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CHAPTER XVIII

MULTIPLE PREGNANCY

The uterus occasionally contains two or more embryos; thus, according to the number present, we have a twin, triplet, quadruplet, quintuplet, sextuplet, or even septuplet pregnancy.

Barfurth states that a tolerably well-authenticated record exists concerning the birth of septuplets at Hameln on the Weser in the year 1600; while Badouin claims that only five credible instances of sextuplet pregnancy have been recorded, and several of these have been subjected to considerable skepticism. On the whole, it may be said that reports of the birth of a greater number of children at a single labor are to be regarded as apocryphal, although many such are to be found in the older literature, the most remarkable being the Rhine legend, according to which the Countess Hagenau was delivered of 365 embryos at a single labor—manifestly an hydatidiform mole.

Frequency.—Wappaeus found that more than one child was born in 1.17 per cent of 20,000,000 cases of labor which he analyzed. The statistics of G. Veit, which were based upon 13,000,000 cases occurring in Prussia, showed that twins occurred once in 89, triplets once in 7910, and quadruplets once in 371,125 labors. Hellin has suggested the following easily remembered ratio: Twins 1 in 80, triplets 1 in 80^2, and quadruplets 1 in 80^3 labors; or once in 80, 6400, and 512,000 labors, respectively. De Blécourt and Nijhoff, in 1904, reported a case of quintuplets, and stated that they found in the literature what appeared to be authentic histories of 28 additional cases.

According to the statistics of Bertillon and Mirabeau, it would appear that multiple pregnancy is more common in cold than in warm climates; while Duncan states that it is noted most frequently in multiparæ, especially between the twenty-fifth and twenty-ninth years. It has been estimated that in 63.1 per cent of the cases only one, and in 36.9 per cent both sexes are represented. Thus, in the 717,907 observations collected by Nichols, both children were males in 234,497, both females in 219,312, and of different sexes in 264,098 cases.

Etiology.—Certain individuals appear to be predisposed toward multiple pregnancy, since it is not unusual for the same woman to give birth to twins or triplets upon several occasions. Thus Puech, upon analyzing 1,262 cases of pregnancy, found that 48 of the mothers had given birth to twins twice, 3 thrice, and 1 upon 4 occasions. In some instances, multiple pregnancy has been known to occur in all the females of a family throughout several generations. Mirabeau has pointed out that an hereditary tendency toward triplet pregnancies was recorded in 13 out of 75 cases collected by him. This was particularly marked in one family, in which the birth of triplets, not to mention twins, had occurred one or more times in five successive generations.

Less frequently, however, this tendency appears to come through the father, and reference is frequently made to the somewhat apocryphal case of the Russian peasant, Wasilef, who is reported to have had 87 children by 2 wives, the first having had 4 quadruplet, 7 triplet, and 16 twin pregnancies; and the second 2 triplet and 6 twin pregnancies. Davenport holds that the hereditary influence is exerted almost as frequently through the father as through the mother, and is due to the presence of unusual numbers of potent and nonlethal spermatozoa. He holds that this is especially evident in couples who had twins in a first marriage, and then married again. In this event the hereditary tendency appeared to be transmitted almost as frequently by the man as by the woman, as the incidence of twins in second marriages was many times greater than in the average family. Winberg, on the other hand, contends that such evidence is not conclusive, as it is based upon random sampling rather than upon the consideration of all of the twin births occurring in a definite area throughout a long series of years.

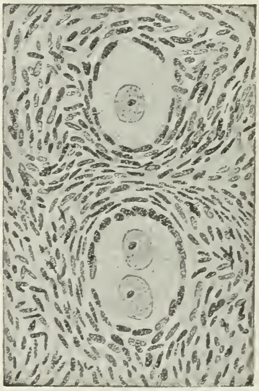

Fig. 345.—Ovum with Double Germinal Vesicle.

Twin pregnancy may result either from the fertilization of two separate ova or of a single ovum, the first giving rise to double-ovum, dizygotic, or fraternal, and the second to single-ovum, monozygotic, or identical, twins. In the former case the ova may come from the same ovary, or one from each ovary; while in the latter only a single ovum in concerned. It is interesting to note that Allen and his associates, in their first communication upon the recovery of human ova from the fallopian tubes, state that in one of their cases a normal ovum was found in each tube on the fifteenth day after the onset of menstruation, and would have given rise to double-ovum twins had each egg been fertilized.

Fraternal twins may or may not be of the same sex, and do not necessarily resemble one another more than other children of the same parents; while identical twins are necessarily of the same sex, and, if they reach maturity, resemble one another closely. Approximately speaking, one out of every four or five sets of twins belong in the latter category; as out of 1887 cases of twin pregnancy analyzed by Prinzing, the incidence of the single-ovum variety was 26.3 per cent, which is in close accord with 24.4 per cent in 262 cases of twins, which I studied personally, as well as with 23.8 per cent noted by Orel in the examination of 501 twin placentæ in Vienna. Weinstein, upon purely theoretical grounds, places the incidence at 21 per cent, and arrived at that conclusion by the following calculation: Assuming that the sexes are approximately equally divided in double-ovum twins, he holds that if the number of pairs—namely, those in which the children are of opposite sex—is doubled and then subtracted from the total number of twins in the series, the result will represent the number of single-ovum twins.

According to Hellin, Patellani, and Larger, multiple pregnancy should be regarded as a sign of atavistic reversion analogous to the litters of many domestic animals, and Hellin states that the ovaries of women who have had a number of multiple pregnancies contain an excessive quantity of ova. According to this view, which can apply only to double-ovum twins, we have to deal with the maturation and fertilization of several ova at a single ovulation period. If heredity is concerned in such cases it can be manifested only by the transmission of abnormally actively functioning ovaries.

Biologically, double-ovum twins are not twins at all, but are simply due to the maturation and fertilization of two ova at a single ovulation period. Single-ovum twins, on the contrary, represent twins par excellence, as is well expressed by Newman—"Strictly speaking, twinning is twaining or two-ing—the division of an individual into two equivalent and more or less completely separate individuals."

Their mode of production has given rise to a considerable literature, to which American investigators have made important contributions. Formerly, it was believed that single-ovum twins were derived from the fertilization of an ovum which presented two germinal vesicles. The existence of such ova is indisputable. Franqué, Klein, and others having reported undoubted examples of such a condition, and Fig. 345 represents an ovum of this character found in one of my specimens. When, however, one considers that for such an ovum to develop into single ovum twins each of its nuclei must undergo typical maturation and cast off polar bodies, and moreover each of the female pronuclei so resulting must be fertilized by a separate spermatozoön, it is apparent that the process is not so simple, as might appear at first sight. Furthermore, the problem is not simplified by accepting the hypothesis of Bromann, and Delucca and Widakowich, that fertilization may be effected by the two heads of a double-headed spermatozoön, whose occurrence they suppose is not infrequent.

For a time Bonnet's theory, that one of the two single-ovum twins might originate from the fertilization of the second polar body before it has escaped from the ovum, enjoyed a considerable vogue, but now it finds few supporters. Recent biological investigations have shown that single-ovum twinning occurs frequently in many species of animals, and can be produced experimentally and at will in several varieties of fish, and also that it is fundamentally associated with the production of monstrosities—the normal twins representing the complete and the monstrosities an imperfect form of the same process.

Stockard has shown that retardation in the growth of the egg, at what he calls critical periods of development, is the essential factor concerned; and has demonstrated that it may be brought about either by exposing the egg to cold or by diminishing its supply of oxygen. When exposed to such retarding influences, just as it is about to undergo gastrulation, the egg may die, or its development rate may be arrested or slowed down for a time, with the result that when growth is resumed two embryonic areas will develop instead of one. If these are far apart two separate individuals will be formed, whereas if the two areas are partially in contact double monsters presenting varying degrees of fusion will result.

Furthermore, Stockard has shown that he can alter at will the degree of duplicity by changing the time at which the retarding influences are brought into play. In other words, he has adduced experimental proof of the closest relationship between single-ovum twins and double monsters, and in human beings one can readily follow all gradations between typical identical twins and the well-known Siamese twins on the one hand, and double-bodied, double-headed or four-legged monsters downward to monsters by inclusion, and finally to teratomata, on the other.

The most striking example of the development of multiple pregnancy from a single egg is afforded by the nine-banded armadillo. As is well known, this animal gives birth to four young at a time, which are always of the same sex and are all inclosed within a common chorion. The details of the process have been exhaustively worked out by Newman and Patterson, and it would appear that the key to it lies in the fact that the fertilized ovum lies quiescent in the uterine cavity for three weeks before placental attachments are formed, and the resulting retardation in growth during this period of quiescence causes a partial loss of polarity, so that when growth is resumed four embryonic areas result instead of one.

Newman in his two monographs—The Biology of Twins, and The Physiology of Twinning—has considered in detail the problems concerned in human beings. He states that single-ovum twins may be due to (1) fission of the blastoderm, (2) double gastrulation, or (3) fission of the bilateral halves of a single embryonic axis. In each instance some retarding factor must come into play, and he considers that any one of the following three possibilities may be concerned:

(*a*) Understimulation of the egg due to some defect in the development-stimulating mechanism of the sperm,

(*b*) Belated placentation due to a failure of the corpus luteum to stimulate the uterine mucosa, and

(*c*) That twinning is an hereditary character dependent upon a recessive gene.

While such explanations may not be entirely satisfactory, enough has been said to indicate that single-ovum twinning is a well-recognized biological phenomenon; does not represent an inherent attribute of the ovum, but is attributable to conditions which affect its rate of growth after fertilization. Accordingly, in human beings at least, its cause may sometimes be sought in environmental conditions with which we are as yet unacquainted. That some fundamental difference exists between single- and double-ovum twins is shown by the fact that in my material 42.2 and 19.1 per cent of the mothers were primiparæ in the two groups, respectively.

In Figure 125 (page 127) is shown one of the earliest examples of human single-ovum twinning. In this specimen, which was described by Streeter, the main embryo was a relatively large structure, while the twin was represented by a small amniotic vesicle and yolk sac imbedded in the connective tissue of the chorionic membrane, just adjoining the body stalk of the larger twin. Figure 346 shows a pig blastocyst described by Streeter, on either side of which lies an embryonic area, which would inevitably have given rise to single-ovum twin had the pregnancy continued, and could only have arisen by the early fission of an originally single embryonic area.

Triplet pregnancy may be derived from one, two or three ova, so that one has to deal with single-ovum, double-ovum or treble-ovum triplets. The first are the least frequent, and according to Sasse, who has described two personal examples and collected 32 others from the literature, the order of incidence of the three varieties is as 1 to 6 to 3. In the only case of quadruplets which I have seen, each child was derived from a single ovum. In the quintuplet pregnancy described by De Blécourt and Nijhoff, three of the children were connected with a single placenta, while each of the other two had separate placentæ; thus indicating that three ova had been fertilized, one giving rise to triplets, and the other two to single children.

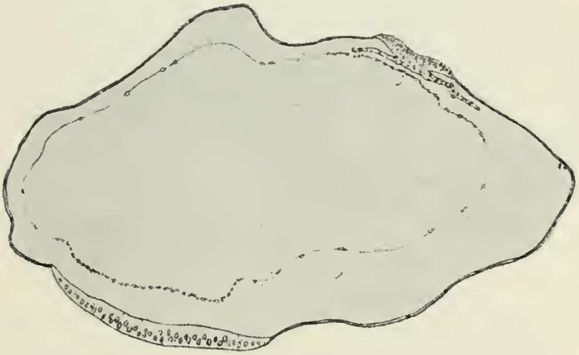

Fig. 346.—Origin of Single-Ovum Twins. Section through a pig's blastocyst, showing two embryonic areas, with a single yolk sac (Streeter).

Relation of the Placentæ and Membranes.—The development of one child in either horn of a bicornuate uterus, or of one twin in the uterus and the other in a fallopian tube, affords indubitable evidence of their origin from two ova; while in uterine twin pregnancy, the examination of the placenta and fœtal membranes after labor usually enables one to determine the mode of origin of the twins. When they are derived from a single ovum, there is a single large placenta from which the two umbilical cords come off; but, when they are developed from two ova, there are usually two separate placentæ, although, when these were originally inserted near one another, their contiguous margins may fuse together, thus giving rise to an apparently single large placenta, in which, however, there is no connection between the circulation of the two twins.

In double-ovum twins, no matter whether the placentæ are separate or fused together, there are always two chorions and two amnions, each child being enveloped in its own membranes. Single-ovum twins, on the other hand, possess only a single chorion, but, as a rule, two amnions, for the reason that the former represents the wall of the original blastodermic vesicle, while the amnion is more directly connected with the embryo itself. In rare instances a single amnion is found. This condition, which was noted in 44 cases collected from the literature by Holzapfel, is not primary, but results from perforation of the partition wall between the two original amniotic cavities.

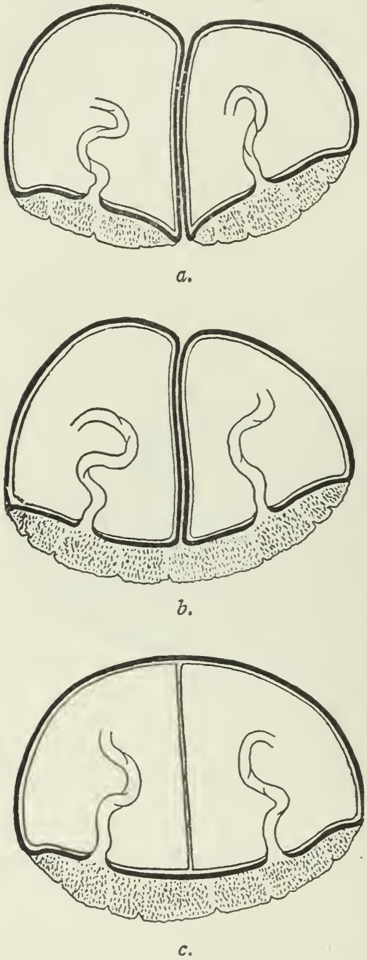

Fig. 347.—Diagram Showing Relation of Placenta and Membranes in Double- and Single-ovum Twin Pregnancy.

a, double-ovum twins; *b*, double-ovum twins, double membranes, single placenta; *c*, single-ovum twins, one chorion, two amnions, and one placenta.

This arrangement of the membranes was known to Viardel in the seventeenth century, who stated that when the children were of the same sex they were usually inclosed in a single amnion, whereas twins of different sexes were separated by a partition wall. He expressed the belief that Providence took this means of guarding their morals *in utero*.

In recent years, Siemens and others have questioned our ability to determine the origin of twins from the relations between the placenta and its membranes, and therefore lay more stress upon the similarity or dissimilarity of the children, particularly when they have advanced beyond babyhood. I believe, with Wagner, that they are in error, and that their skepticism is based upon imperfect knowledge and experience.

In triplet pregnancy, the conditions are still more complicated. If only one egg is concerned, one has to deal with a single large placenta with one chorion and three amnions. In two-egg triplets, two eventualities are possible: (1) a single large placenta, which has resulted from the fusion of a single placenta and of another belonging to single ovum twins. This is clearly shown in Figure 348, which was drawn from one of my specimens. Or (2), the two placentæ are separate and not fused. On the other hand, if three ova are concerned, three eventualities are possible: (1) three separate placentæ, each with its own chorion and amnion; (2) two separate placentæ, one single and the other fused, the latter being a double-ovum twin placenta, as shown in

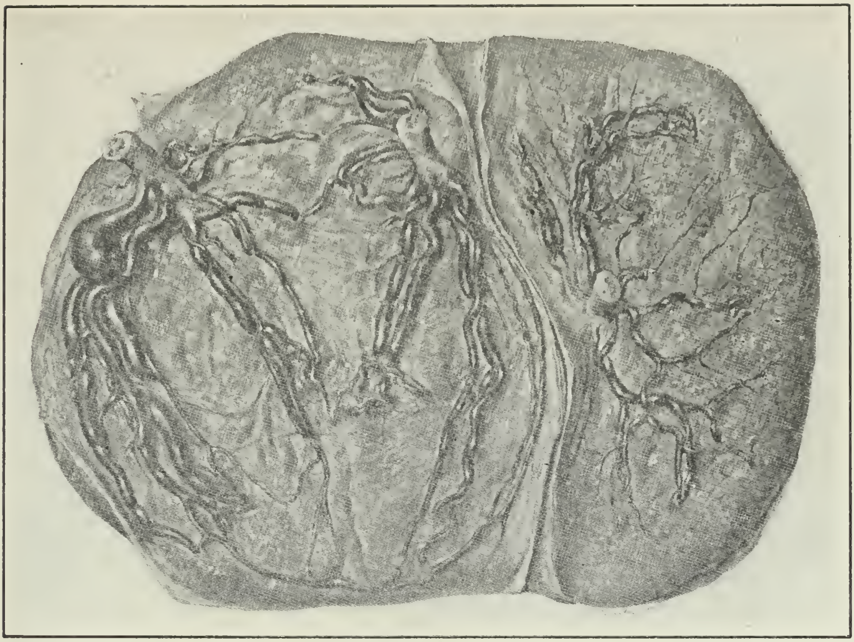

Fig. 348.—Triplet Pregnancy from Two Eggs. × ⅓.
One child from the right side of the fused placenta, and single ovum twins from the larger left side.

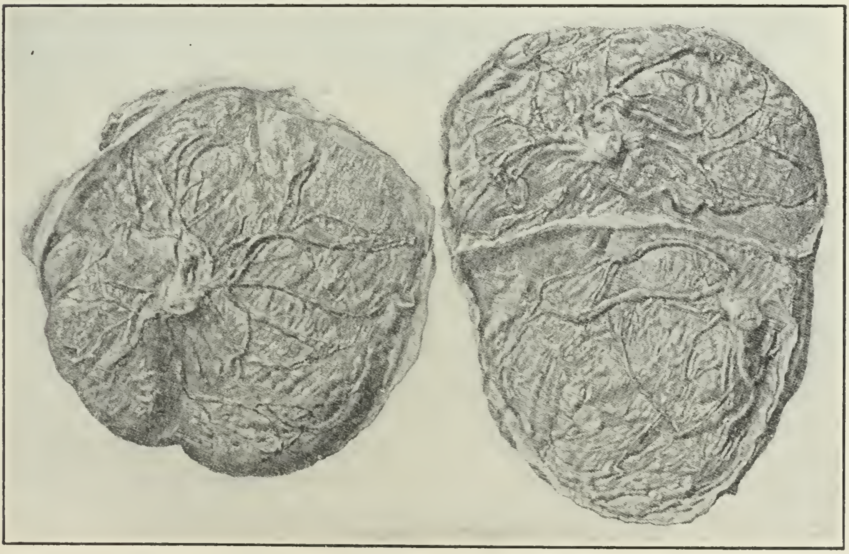

Fig. 349.—Triplet Pregnancy from Three Eggs. × ⅓.
One child from the smaller single placenta, and double ovum twins from the larger fused one.

Figure 349, and (3) a huge single placenta, each with its own chorion and amnion, as shown in Figure 350.

In quadruplet pregnancy the conditions may be still more complicated and even more eventualities are possible. In the only example I have studied, four eggs were concerned, and had given rise to two placentæ—one a single one with its own chorion and amnion, and the other an immense fused placenta with three fœtal areas, each with a complete set of membranes.

In single-ovum twins there is always a certain area of the placenta in which there is anastomosis between the two vascular systems, which is never present in the fused placenta of double-ovum twins. This condition, which has been exhaustively studied by Schatz, and well reviewed by Newman, occasionally leads to serious consequences. Thus, if at an early period the heart of one embryo is considerably stronger than that of the other, a gradually increasing area of the communicating portion of the placenta is monopolized by the former, so that its heart increases rapidly in size, while that of the latter receives less and less blood and eventually atrophies. Herein is to be found the explanation of the deformity known as *acardia*. In such cases almost the entire placental circulation is utilized by the normal embryo, while the deformed twin receives only enough blood to nourish its lower extremities; while occasionally it is represented only by a shapeless mass of tissue—acardius amorphus.

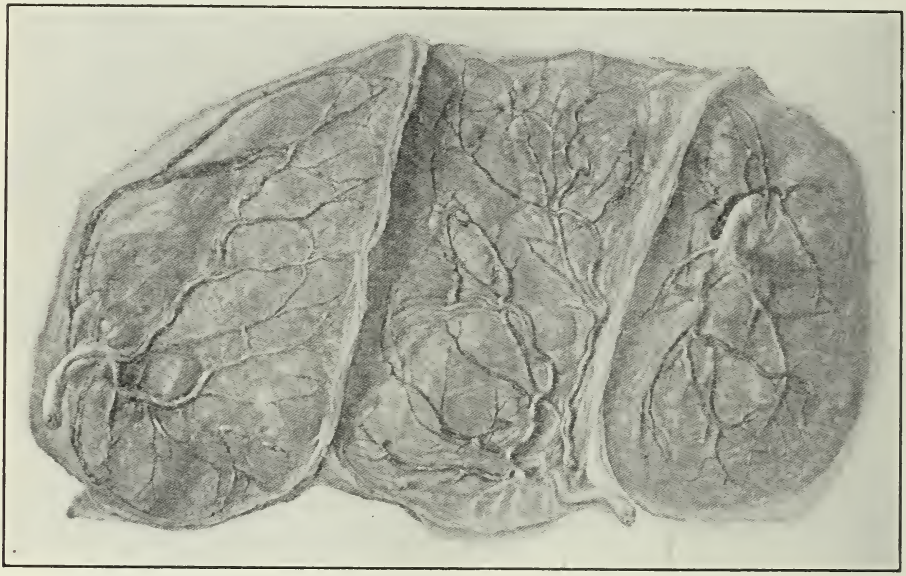

Fig. 350.—Fused Three-Egg Placenta from a Quadruplet Pregnancy. × ¼. One child from a single placenta not shown in the drawing, and three-egg triplets from the fused placenta.

In other instances a difference in the strength of the two hearts leads to the production of hydramnios in the larger ovum. In such cases it is believed that the stronger heart appropriates an ever-increasing share of the blood from the placenta and undergoes hypertrophy, which in turn is followed by an hypertrophy of the kidneys, which leads to increased urinary secretion and a consequent excess in the quantity of amniotic fluid.

In the rare instances in which single-ovum twins are inclosed in a common amnion, their umbilical cords may become so twisted about one another as to interfere with the circulation through them, and thus lead to death and an early termination of pregnancy. Sonntag, in 1905, collected 23 such cases from the literature.

Ordinarily, in twin pregnancies, whether derived from one or two ova, each child occupies, roughly speaking, one-half of the uterus, the long axis being directed vertically. Occasionally, however, they run transversely, so that one fœtal sac comes to lie above the other. In such circumstances, the placenta and membranes of the first child must be expelled from the uterus before the second child can be born, unless the latter can make its way past them. Unless the uterus contains an excessive amount of amniotic fluid, it is evident that its more voluminous contents must be subjected to greater pressure than in the case of single pregnancies. In this event the twins are brought into the closest contact and may be markedly molded.

Generally speaking, twins are smaller and weigh less than children resulting from single pregnancies, although their combined weight is usually greater than that of a single child. The smaller size may be considered normal, but in some instances is partially to be explained by the fact that the excessive distention of the uterus tends to premature labor, so that the twins are born several weeks before maturity. According to Ribemont-Dessaignes, this occurs in 83 per cent of primiparæ, and in 75 per cent of multiparæ.

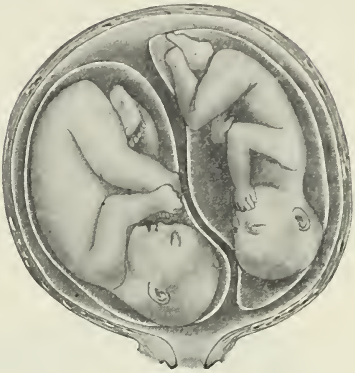

Fig. 351.

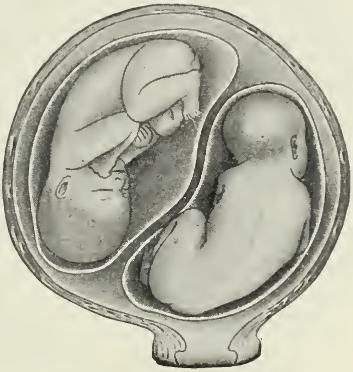

Fig. 352.

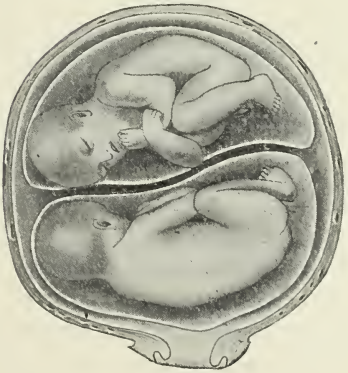

Fig. 353.

Figs. 351-353.—Diagrams Showing Position of Twins in Utero.

It is not unusual for twins to differ considerably in size and weight, especially when derived from a single ovum. Ahlfeld has reported cases in which the twins weighed, respectively, 2320 and 1120, and 1920 and 790 grams.

In double-ovum twin pregnancy one child may die at an early period and be expelled from the uterus soon afterward, while the other may go on to full development. More frequently, however, the dead fœtus is retained until the end of pregnancy, and, being compressed between the uterine wall and the membranes of the living child, becomes flattened out and partially mummified—*fœtus papyraceus* or *compressus* (Fig. 354).

Superfecundation and Superfetation.—The consideration of the difference in the weight of twins, and the possibility of one being aborted while the other develops until full term, leads up to the question of superfecundation and superfetation. By the former, we understand the fertilization of two ova within a short period of one another, but not at the same coitus; whereas in the latter several months may intervene.

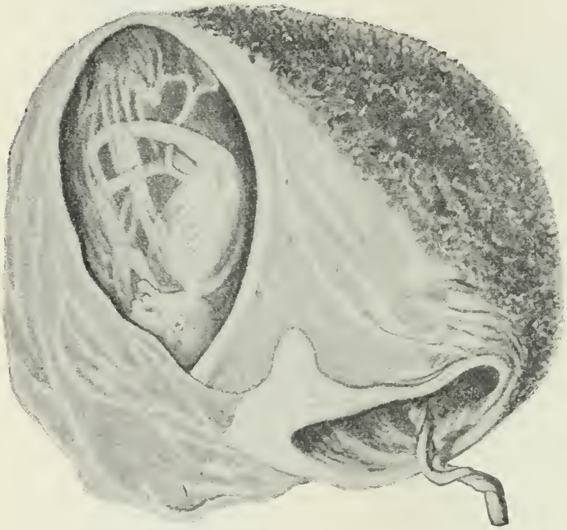

FIG. 354.—FŒTUS PAPYRACEUS (Ribemont-Dessaignes).

Superfecundation is a well-recognized occurrence in the lower animals, and undoubtedly occurs in human beings, although it is impossible to determine its frequency. It is probable that in many cases the two ova are not fertilized at the same coitus, but this can be demonstrated only under exceptional circumstances. It is interesting to note that John Archer, who was the first physician to receive a medical degree in America, related in 1810 that he had observed a white woman, who had had connection with a white and a colored man, respectively, within a short period, and who was delivered of twins, one of which was white and the other a mulatto. A still more convincing case was recorded by Robertson. In this instance a mare was covered by a horse and ten minutes later by a jackass and gave birth to twins, one being a horse and the other a mule. Some years ago in my clinic, the sixth pregnancy of a colored woman terminated in the birth of twins, one being macerated and the other perfectly healthy. Autopsy and microscopic examination of the placenta of the first child gave indubitable evidence of syphilis, while the second child showed no signs of the disease. On questioning the patient, who presented no manifestations of syphilis, it was ascertained that she had had connection with her husband and with another man within a period of a few days, and that the latter was under treatment for syphilis at the time. From this it might be inferred that the normal child was engendered by the husband, and the syphilitic one by the lover, and the inference is rendered more probable by the fact that the patient was delivered in the service twice before and thirteen times after this event, and none of the other children or placentæ showed any sign of syphilis.

The occurrence of superfetation has never yet been demonstrated, though its theoretical possibility must be admitted, as long as the uterine cavity has not become obliterated by the fusion of the decidua vera and reflexa. As this occurs at the end of the third month of pregnancy, superfetation is out of the question after that time; but prior to that there is no theoretical objection to supposing that, should ovulation occur, a second ovum might find its way into the uterine cavity and there be fertilized. Still more favorable conditions would be afforded by a duplex uterus.

Certain French authorities consider that such an event has been conclusively demonstrated, and many of the arguments which have been advanced in its favor are given by Tarnier. On the other hand, most English and German authors are skeptical, and believe that the majority of instances put under this category have been due either to the abortion of one twin or to marked inequality of development. Moreover, the fact that ovulation is usually in abeyance during pregnancy still further diminishes the probability of such an occurrence. The arguments against the occurrence of superfecundation were well reviewed by A. W. Meyer, in 1919.

Cases occasionally occur which at first glance appear to bear out the possibility of superfetation, but, upon closer study, fail to do so. Thus, a physician sent me two fœtuses which he thought afforded conclusive evidence in favor of such an occurrence. They had been expelled spontaneously by a healthy multipara, who thought herself four and one-half months pregnant. One fœtus measured 18, and the other 4 centimeters in length. The former was perfectly fresh, while the latter showed signs of atrophy and had evidently been dead for some time, so that there was but little doubt that each had begun development at about the same period. Even had both fœtuses been alive, the evidence would not have been unassailable, unless both placentæ presented identical conditions upon examination; as it is conceivable that some lesion might have been present in the placenta corresponding to the smaller child, which would seriously interfere with its growth, without, however, causing its death.

In this connection a word may be said concerning *telegony,* by which is meant the possibility that something is added to the mother at the time of the first conception, which will be transmitted to later offspring even though originating from another mate. This doctrine is so much an article of faith among veterinarians that they hold that the breeding qualities of a highly bred mare or bitch inevitably suffer if she is ever covered by a male of inferior breed. The article of Tcherepoff shows that many physicians hold similar views, but all scientific biologists contend that they entirely lack foundation.

Diagnosis.—It sometimes happens that the first intimation which the physician has of the presence of twins is afforded by the unusually large size of the uterus after the expulsion of the first child. Despite this fact, however, it may be said that such surprises will rarely occur in the practice of those who take the trouble to make a thorough preliminary examination.

Excessive size of the abdomen during pregnancy frequently causes one to suspect the presence of twins, though usually it will be found to be due to some other condition. Thus, owing to the relaxation of the abdominal walls following the birth of the first child, women pregnant for the second time often think that they will give birth to twins, although, as a matter of fact, their fears are generally without foundation.

The diagnostic means at our disposal are palpation, auscultation, touch, and the x-ray. If a multiplicity of small parts is encountered on palpation, the possibility of a twin pregnancy should always be suspected. Positive evidence is afforded by the palpation of two heads, two breeches, and two backs; or at least of one back and four fœtal poles. The detection of three fœtal poles is not conclusive, for the reason that in rare instances a subperitoneal or intramural myoma may simulate the head of a child.

Auscultation frequently gives most valuable information, and if one can distinguish two areas, considerably removed from one another, in which a fœtal heart can be heard, twins should be suspected; but a positive diagnosis should not be made unless there is a difference of at least 10 beats per minute in the rate of the two hearts, the sounds being counted for at least a minute in each location.

In rare instances vaginal touch may reveal important findings, as it is sometimes possible to distinguish a macerated head through the intact membranes, or a prolapsed and pulseless cord may be felt through the cervix, while auscultation gives positive evidence of the presence of a living child.

Gauss, in 1910, pointed out that the presence of a second child *in utero* may materially alter the manner of descent of the first through the pelvis. Accordingly, he considers that the existence of a twin pregnancy is indicated whenever vaginal examination shows a head deep in the pelvis in an anterior parietal presentation—that is, with the sagittal suture lying transversely and well posterior to the midline.

In doubtful cases, the use of the röntgen ray sometimes enables one to make a positive diagnosis by detecting the skeletons of two children in the plate. On the other hand, a negative finding does not preclude the possibility of twins, as, owing to the unfavorable conditions under which the picture must be taken, the presence of the second child may not be revealed.

The presence of more than two children can be predicted with certainty only under very exceptional and favorable circumstances, although Ribemont-Dessaignes, in 1894, reported the diagnosis of triplets during pregnancy, and its confirmation at the time of labor. When such a suspicion arises, certainty is sometimes secured by means of the x-ray. My former assistant, R. A. Johnston, made correct diagnosis by that means, while Marcus and others have reported similar successes.

Course of Labor.—We have already referred to the excessive size of the uterus resulting from the presence of twins, which may be still further increased by hydramnios of one ovum. This may give rise to considerable discomfort, the patient suffering markedly from dyspnea, pressure symptoms, and edema.

Occasionally, the extreme stretching of the uterus may lead to an early dilatation of the cervix. Reference has already been made to the frequency of premature expulsion in these cases; and when labor sets in, owing to the overdistention and inertia of the uterus, the pains usually occur at long intervals and are lacking in intensity, so that the birth of the first child is often prolonged. The cord of this child should be cut between double ligatures, as failure to ligate its maternal end may lead to the death of the second child from hemorrhage, if the twins are derived from a single ovum.

Generally speaking, the membranes of the second child appear at the cervix immediately after the first is born and soon rupture. Its expulsion usually follows the first within half an hour, 75 per cent of the cases collected by Kleinwächter occurring within this period; while in the remainder a longer time elapsed—as much as twelve hours in 7 of his cases. If spontaneous delivery of the second child does not occur within a reasonable time, interference is indicated, and the practice formerly in vogue of waiting hours for its spontaneous expulsion cannot be reprehended too strongly.

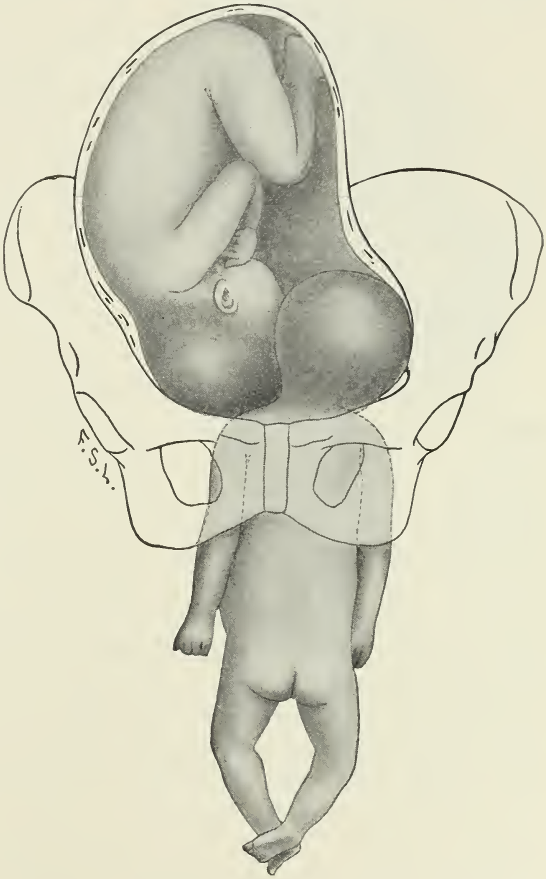

Fig. 355.—Diagram Showing Collision between Heads of Twins.

Changes in position of the second child frequently occur during and just after the birth of the first, so that at this time a renewed examination is necessary in order that any abnormality may be detected and the proper measures taken. The condition of the fœtal heart should also be carefully watched, and delivery immediately effected if it becomes abnormal. As a rule, the placenta of the first child remains in situ until the completion of labor, but in rare instances it may become partly or completely separated and give rise to hemorrhage. Under these circumstances the second child should be delivered without any delay.

In most cases both twins present by the vertex, though not very rarely one descends by the breech. In 1849 cases analyzed by Leonhardt, the following conditions were noted:

First Twin	*Second Twin*	*Per Cent*
Vertex	Vertex	38.53
Vertex	Breech	21.19
Breech	Vertex	14.35
Breech	Breech	10.76
Vertex	Transverse	8.32
Breech	Transverse	4.29
Transverse	Vertex	0.87
Transverse	Breech	0.77
Transverse	Transverse	0.92
Total		100.00

Except for the delay incident to uterine inertia, delivery in twin pregnancy usually causes but little difficulty, provided an accurate diagnosis of the presentation of the children has been made. Consequently, it is difficult to understand why many physicians approach the matter with grave forebodings, and fear that they may have to deal with one of the complications, which are about to be mentioned, but which occur so rarely that I have not encountered them in over three hundred twin deliveries. Occasionally, when the children are small in size, their presenting parts may both attempt to enter the superior strait at the same time, and thus mutually interfere with one another. This complication is known as *collision,* and may occur when both children present by the vertex, or when one presents by the head and the other by the breech. In the first case, an attempt should be made to push up the presenting part which is less distinctly engaged, and then to deliver the other child rapidly. If this is not possible, the whole hand should be introduced into the uterus and the condition of affairs carefully studied. Occasionally it will be found advisable to apply forceps to the uppermost child and attempt to drag it past the other. In rare instances craniotomy upon one child may be indicated.

Now and again during extraction, when the first child presents by the breech and the second by the vertex, the two heads may become locked just above the superior strait, that of the second fitting into the neck of the child and making its delivery impossible. Under such circumstances, if the head of the second child cannot be displaced, the first child should be decapitated, as it must inevitably perish during any attempt at extraction; after this the body should be brought away and the second child then delivered by forceps.

In rare instances, the first child may present transversely and be straddled by the second in such a manner that the legs of the latter protrude from the cervix. Traction upon them will serve only to wedge the shoulder of the other child more firmly into the pelvis and give rise to insuperable difficulties. The proper treatment can only be determined after careful examination under anesthesia, with the entire hand in the uterus, but when the condition of affairs has been clearly visualized, a little mechanical ingenuity will readily enable one to determine whether version or decapitation is the operation of choice.

Owing to previous overdistention, the uterus sometimes fails to contract and retract satisfactorily during the third stage of labor, so that abnormalities in the placental period are not infrequent. If there is any tendency toward an excessive loss of blood, the obstetrician should immediately express the placenta by Credé's method, instead of waiting for the fundus to rise up. Occasionally the area of placental attachment may be so large that abnormalities in its detachment may render necessary its manual removal. This operation, however, should not be resorted to unless urgently indicated.

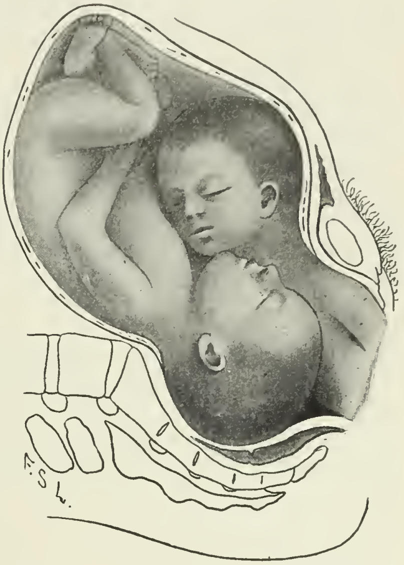

Fig. 356. — Diagram Illustrating Locked Twins (American Textbook).

The danger of hemorrhage does not end with the expulsion of the placenta, as the uterus sometimes relaxes during the hour immediately following. Accordingly, the physician should remain with the patient for some time after the completion of labor and give his personal supervision to the condition of the uterus, kneading it upon the first indication of relaxation, and reënforcing it by the hypodermic administration of pituitary extract and ergot. Neglect in this direction has sometimes led to the death of the patient from postpartum hemorrhage.

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SECTION V

OBSTETRIC SURGERY

CHAPTER XIX

INDUCTION OF ABORTION AND OF LABOR—ACCOUCHEMENT FORCÉ

Preparations for Obstetrical Operations.—Owing to the increased manipulation within the generative tract incident to an obstetrical operation, any lack of cleanliness entails even more risk than in the case of normal labor. Accordingly, the maintenance of a rigid aseptic technic is as absolutely imperative as in major surgical operations.

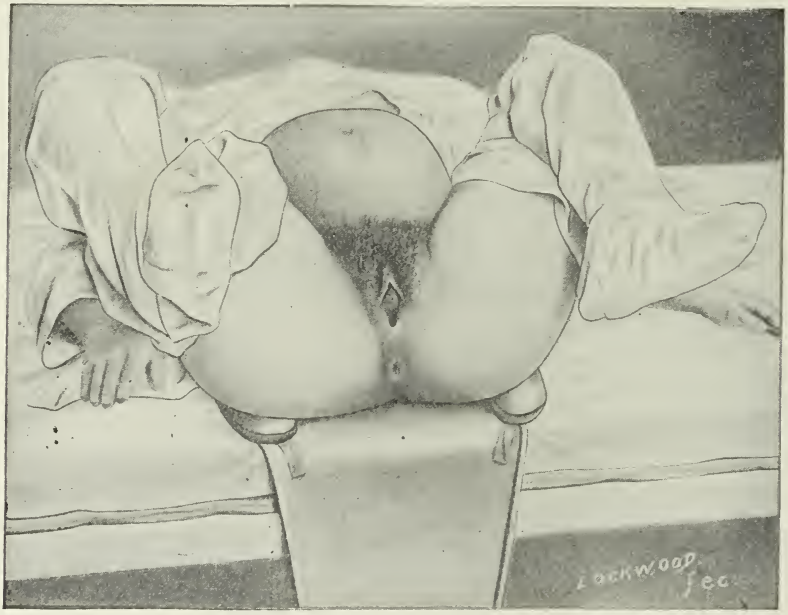

Fig. 357.—Showing Patient at Edge of the Bed, with Legs Held in Position by Legholder.

The hands of the operator and his assistants should be thoroughly washed and disinfected, as described in Chapter XV, and then encased in sterile rubber gloves. A sufficient quantity of dressings, towels, gauze, and ligatures, carefully sterilized beforehand, should be in readiness. All instruments should be rendered sterile by boiling immediately before the operation. As an emollient, petrolatum, albolene, or liquid green soap, which has been sterilized by boiling in small jars, may be used.

The pubic hairs should be shaved, and the external genitalia, together with the pubic region and the inner surface of the thighs, thoroughly swabbed with a 4 per cent solution of mercurochrome in alcohol and acetone, which in my hands has proven quite as satisfactory as tincture of iodine, picric acid or other substances. If the patient is not infected, I make no attempt to disinfect the vagina, but if signs of infection are present, or if the patient has been subjected to repeated vaginal examinations, or to attempts at delivery, I instill the mercurochrome solution, and with the fingers rub it into the irregularities of the vaginal wall.

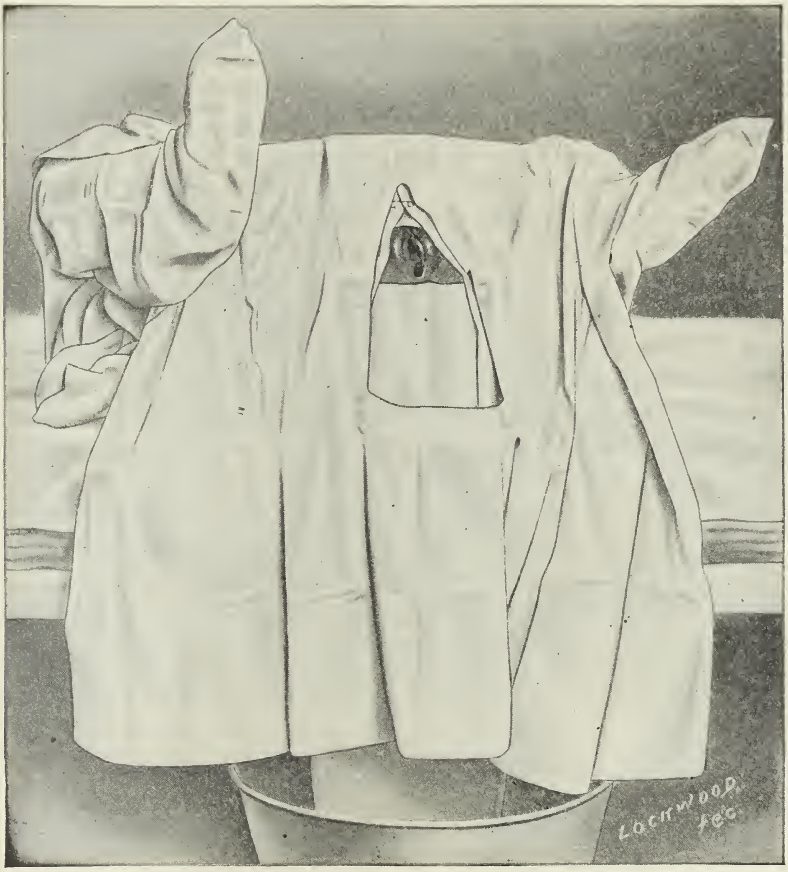

Fig. 358.—Showing Patient Covered with Sterile Dressings Preparatory to Operation.

Before the sterile dressings are put in place, the bladder should be emptied by means of a sterile rubber catheter. In the early months of pregnancy, a distended bladder interferes with bimanual manipulations, at labor it may effect the engagement of the presenting part, and after the birth of the child it may interfere with the proper conduct of the third stage of labor.

Obstetrical operations, with the exception of podalic version, cesarean section and other laparotomies, are usually undertaken with the patient in the lithotomy position. In hospitals, a suitable operating table is always available; while in private practice, as the low beds now in use are very inconvenient, it is advisable to place the patient upon a narrow table. One that will answer the purpose quite satisfactorily is usually to be found in every kitchen, but, if a suitable table is not available, a satisfactory makeshift may be improvised by unscrewing the mirror from a bedroom bureau. Anesthesia is indispensable for all but the simplest procedures, and if it is to be prolonged, ether is safer than chloroform, on account of the late poisoning which sometimes follows the use of the latter drug. As soon as the patient is fully under its influence, her buttocks should be brought to the edge of the table, and her legs held in place by a legholder. The nightgown should be rolled up above the hips to avoid soiling, and, as soon as the external genitalia have been prepared, the legs should be encased in sterile leggings, and the abdomen and buttocks covered with sterile towels in such a manner as to leave only the genitalia exposed. To avoid the possibility of contamination from the rectum, it is advisable to cover the anus with a folded sterilized towel, which can be held in place by a strip of adhesive plaster passed over the buttocks, or better still by small clip forceps which attach it directly to the skin. Finally, a specially prepared sterile sheet should cover everything except the immediate field of operation.

Induction of Abortion.—By this term is understood the artificial termination of pregnancy before the fœtus has attained viability—namely, prior to the twenty-eighth week. The operation dates from remote antiquity, and more or less accurate directions for its performance are to be found in the earliest writings upon medicine. It was so extensively practiced in Rome that we find it repeatedly referred to by Plautus, Juvenal, and other secular writers as a matter of everyday occurrence. With the spread of Christianity, however, it came to be considered as criminal, except when undertaken as a last resort in order to save the life of the mother; and we now draw a sharp distinction between criminal and therapeutic abortion. For historical details the reader is referred to the works of Levin and Brenning, Brouardel, and Kleinwächter.

Indications.—Three groups of conditions may offer an indication for the induction of therapeutic abortion. Thus we only think it our duty to resort to it: (1) as a direct means of saving the life of the mother; (2) to do away with a condition which may threaten her life if gestation continues; and (3) to avoid certain dangers which may supervene if pregnancy is allowed to progress to full term.

Under no circumstances should an abortion be undertaken, unless a thorough examination has demonstrated that the condition of the patient is really serious.

Consequently, the so-called social and eugenic indications do not find favor with reputable obstetricians, no matter how strongly they may appeal to their sympathy. The statements of the patient are entitled to but little weight, and the decision to interfere must be based entirely upon objective symptoms and clinical findings. Moreover, it should never be made without consultation with a second physician, who assumes his share of the responsibility. This precaution, besides securing for the patient additional advice, will protect the physician from possible blackmailing on the part of unscrupulous persons.

In the first group, the best-recognized indication for the operation is afforded by pernicious *vomiting of pregnancy*. In most instances this condition is in great part neurotic in origin and can be cured by appropriate measures. More rarely, however, it is a manifestation of a profound toxemia, as will be described in the chapter on the toxemias of pregnancy. If the latter diagnosis be established, the prompt induction of abortion is urgently demanded, as we know by experience that it offers the only hope of saving the life of the patient.

Prior to the recognition of the varying nature of this condition, there was a natural hesitancy on the part of the physician to interfere owing to the fact that in many cases the vomiting ceased spontaneously, or was relieved by treatment. For that reason, the operation was frequently postponed until the condition of the patient had become so serious that death was the inevitable consequence, whether abortion was induced or not. Now that we know more about it, interference is rarely necessary except in the severe toxemic type.

The induction of abortion is likewise indicated when the uterine contents have become infected, with the process still limited to the uterus, as so frequently follows attempts at *criminal abortion*. Under such circumstances, if the fœtus has not already succumbed it will almost certainly die, and the greatest chance of saving the woman's life lies in promptly emptying the uterus and cleaning its cavity. On the other hand, if the infectious process has extended beyond that organ and has involved the tubes, ovaries or peritoneum, it is advisable to wait until defervescence has occurred before interfering, as experience teaches that attempts to complete the abortion in such circumstances expose the patient to greater danger than if a more conservative course is followed.

Formerly it was believed that abortion should be induced for incarceration of the *retroflexed pregnant uterus,* as well as in the rare cases of hernia of that organ, inasmuch as death may result if the patient be left to herself. At present, however, unless infection has supervened, better results are obtained in the former condition by performing laparotomy, freeing the uterus from adhesions and replacing it in a normal position, after which pregnancy may pursue an uninterrupted course.

In the second group, preëclamptic toxemia, chronic nephritis with pronounced *renal insufficiency* may necessitate the operation. But inasmuch as such conditions usually only become serious later in pregnancy, they will be considered when we take up the induction of premature labor. With the extension of renal surgery, it is not uncommon for pregnancy to supervene in women from whom one kidney has been removed. If the remaining organ is normal, pregnancy proceeds uneventfully, as is shown by the fact that Matthews was able to collect 265 labors occurring in 241 nephrectomized women with only two deaths. On the other hand, if the remaining kidney shows signs of chronic nephritis, pyelitis or calculus formation, prompt termination of pregnancy is essential if fatal damage is to be avoided.

Diseases of the ovum, such as hydatidiform mole, occasionally afford an indication for the operation. No matter at what period of pregnancy the latter condition is diagnosticated, the uterus should be emptied at once, as in such circumstances the fœtus is either lacking or very imperfectly developed, and, if the diseased chorion be allowed to remain in the uterus, a chorio-epithelioma may develop.

Uterine hemorrhage in the early months of pregnancy is generally a sign of threatening abortion, but, if after appropriate treatment the loss of blood continues for some time, and is not followed by spontaneous abortion, it is usually associated with some abnormality on the part of the ovum, and indicates that the uterus should be emptied artificially. The rare cases of *missed abortion,* in which the ovum is retained for months after the death of the embryo, sometimes afford an indication for interference. In not a few cases, however, and especially when the patient presents no abnormal symptoms, a more conservative policy may result in a spontaneous outcome.

The indications in the third group are principally afforded by pulmonary tuberculosis, and occasionally by other chronic diseases. Formerly, the induction of abortion at an early period was considered justifiable when the pelvis was so contracted as to present an absolute indication for cesarean section; but at present, in view of the excellent results which attend the latter operation, this view is no longer held. The same applies to the presence of *uterine myomata.* If pronounced pressure symptoms are present myomectomy or hysterectomy should be performed without regard to the existence of pregnancy; but if the tumor promises to act merely as a mechanical obstacle at the time of labor, pregnancy should be allowed to go almost to term, and cesarean section then performed, followed by removal of the tumor or of the entire uterus, as seems most advisable.

Ovarian tumors complicating pregnancy do not call for the induction of abortion, but should be removed by laparotomy as soon as the diagnosis is made. This can frequently be done without causing interruption of the pregnancy, when spontaneous delivery will occur at term.

The induction of abortion is not indicated in *malignant growths* involving the uterus or adjacent organs. In carcinoma of the cervix, the treatment to be pursued differs according to circumstances. If the condition be operable, immediate hysterectomy is indicated without regard to the existence of pregnancy; but if the disease has progressed too far to offer a prospect of permanent cure after operation, gestation should be allowed to continue in the interests of the child, which should be delivered at term by the procedure most appropriate to the particular case.

Owing to the well-known fact that pulmonary tuberculosis usually progresses much more rapidly after childbirth, it is advisable that tuberculous women take every precaution to avoid the possibility of conception. If conception occurs, however, a difficult problem arises. Up to 1926, I felt very strongly that it was my duty to induce abortion as soon as possible after the diagnosis was made, in the hope that by ending the pregnancy, and placing the patient in proper surroundings afterwards, the disease might be arrested. In that year, however, Bridgman and Norwood, after analyzing 134 cases observed in my service, found that fewer deaths had occurred in the women who were left alone than in those upon whom abortion had been done. Since then I have ceased to regard abortion as routinely indicated and have restricted its employment to specially selected cases. Moreover, I feel very strongly that a second abortion should not be done after the patient has been warned to avoid the possibility of becoming pregnant until after the disease has been cured or arrested.

Methods of Inducing Abortion.—The methods of inducing abortion vary according to the duration of pregnancy. In the first few months, and particularly in multiparous women, the operation can frequently be completed at a single sitting, if necessary, whereas between this period and the seventh month the methods employed for the induction of premature labor are more appropriate. In the first period, if the cervix is somewhat softened, it can usually be sufficiently dilated by means of Goodell's instrument, followed by Hegar's graduated dilators, to admit one finger. The entire hand, anointed with sterile petrolatum, is then introduced into the vagina and the index finger carried up into the uterine cavity. While the other hand, placed upon the abdomen, forces the uterus downward, the finger within its cavity separates the placenta from its attachments, after which the product of conception is removed entire or is broken up into small pieces, which can be removed by means of an abortion or ovum forceps. Following this, the interior of the organ should again be explored to make sure that it is empty. In many instances the use of a general anesthetic is not necessary, as satisfactory anesthesia may often be obtained by injecting procaine deeply into the cervix and parametrium by means of a long needle.

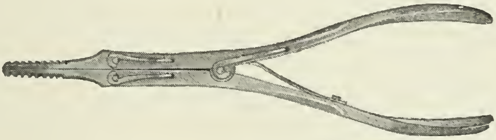
FIG. 359.—GOODELL'S DILATOR.

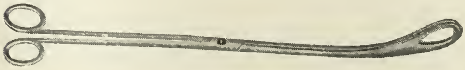
FIG. 360.—OVUM FORCEPS.

To attempt to empty the uterus blindly by means of a curet and ovum forceps is unwise, inasmuch as cases are occasionally reported in which such procedures have caused perforation. More frequently fragments of the placenta are left in the uterus, giving rise by their presence to serious hemorrhage and occasionally to infection. In other instances only a portion of the decidua is curetted away, while the ovum is left in situ and goes on to further development. Accordingly, one can never feel sure that the operation is complete, unless a finger has been introduced into the uterus and has carefully palpated its interior.

Particularly in women pregnant for the first time, the cervix may be so resistant that rapid dilatation can be effected only at expense of deep laceration. In such circumstances, if haste is not imperative, a strip of sterile gauze may be tightly packed into the cervical canal and the vagina firmly tamponed with the same material. When the pack is removed at the end of twenty-four hours, the entire ovum will sometimes follow it; while in other cases the cervix will be sufficiently softened to permit its dilatation with a suitable instrument. The employment of a laminaria tent was formerly recommended by many authorities, and affords an efficient means of slow dilatation, but, as tents cannot be sterilized satisfactorily, their use adds to the risk of infection.

Abortion is sometimes induced by perforating the membranes with a sterile sound and allowing the liquor amnii to drain off. In addition to increasing the danger of infection, the desired result does not always follow, and it frequently becomes necessary to supplement it by one of the procedures just described, so that the maneuver is not to be recommended.

On the other hand, when rapid dilatation is not feasible, and it is desired to complete the abortion at one sitting, the uterus may be readily and rapidly emptied after vaginal hysterotomy. The details of this operation, which I employ with increasing satisfaction and frequency each year, will be found under Vaginal Cesarean Section.

In the case of unintelligent women of the lower classes suffering from active tuberculosis, chronic nephritis, serious cardiac lesions and certain other conditions, as well as in certain feebleminded or imbecile individuals, the mere induction of abortion, and the injunction to avoid the possibility of future pregnancies, are not satisfactory; as a large proportion of such patients soon become pregnant again, when the propriety of repeated interference must be considered. For a number of years I have faced the problem more radically, as I hold that in such patients it is justifiable to follow the abortion by a sterilizing operation; while in those suffering from a disease which offers a reasonable prospect of eventual cure the abortion should be followed by some procedure, which will insure sterility for as long a period as may be necessary, and yet leave a possibility for the occurrence of conception after the underlying disease has been cured.

In either event, I effect abortion by performing a miniature cesarean section. In the first class of patients, I follow this by supravaginal hysterectomy with retention of the ovaries, provided they no longer desire to menstruate; while if they do, I close the uterine wound by means of interrupted sutures, and then excise the uterine ends of the tubes from the cornua, taking care to bring the peritoneal covering into the closest approximation. On the other hand, in the second class of patients, after closing the uterine incision, I effect temporary sterility by ligating and severing the tubes at the junction between their proximal and middle thirds. After this the uterine end of the broad ligament is spread apart, the corresponding end of the tube buried within it, and the wound closed by fine sutures.

This procedure is technically easy and effectively sterilizes the patient without any loss of tissue. Later, should it be thought desirable to restore the possibility of conception, the abdomen can be reopened and the proximal ends of the tubes freed and united by fine sutures to the distal ends. I have not yet had occasion to resort to the second operation, and I imagine that it will be desired but rarely. At the same time, the knowledge that it is possible has a valuable psychological effect upon the patient, which is lacking when more radical means of sterilization have been employed.

In recent years a considerable literature has arisen concerning the induction of abortion, followed by temporary or permanent sterility, by exposure to the action of the röntgen ray, and it is generally admitted that in the early months of pregnancy, where haste is not essential, it is possible to destroy the product of conception and to effect its expulsion by such means. It is further claimed that following such treatment temporary or permanent sterility will follow according to the length of exposure and intensity of the dosage. Several objections are advanced against the method. In the first place, the intended permanent sterility does not always result, while the duration of the temporary sterility cannot always be regulated, and consequently pregnancy sometimes occurs when least desired. A much more serious objection lies in the fact that when ovulation becomes reëstablished abnormal ova may be cast off, which when fertilized may result in defective children, as is shown by the review of Wintz. Desjardins of the Mayo Clinic holds that such dangers are practically negligible and relies upon the experimental work of Robinson to support his statement. On the other hand, Murphy stated in 1928 that careful study of the literature upon the subject proves that the development of abnormal or deformed children is not uncommon. For these reasons, it would seem safer to limit the use of such methods of inducing abortion and subsequent sterility to those late in their reproductive career.

Prognosis.—The prognosis in therapeutic abortion varies according to the indication for which it is undertaken, but, with the patient in fairly good condition, satisfactory results should always follow, provided a proper technic is observed. In my hands vaginal hysterotomy has proved a much more satisfactory and less dangerous procedure than forced instrumental dilatation of a rigid cervix.

Induction of Labor.—By the term induction of premature labor we designate the artificial termination of pregnancy after the child has reached the period of viability—that is, after the twenty-eighth week; whereas, we speak of the induction of labor when the pregnancy has approached or reached full term. The former operation was performed by Guillemeau, Mauriceau, Justine Siegemundin, and others in isolated cases for hemorrhage, but, according to Denman, it was not generally advocated until 1756, when a conference of physicians was held in London to devise means for doing away with the frightful mortality then following cesarean section for contracted pelvis.

Indications.—The indications for the induction of premature labor are threefold: to obviate the dangers attending delivery at term through a contracted pelvis; to save the life of the mother, when seriously threatened by some disease from which she may be suffering; or to end a pregnancy complicated by some pathological condition of the ovum. On the other hand, the induction of labor is usually indicated in order to effect the delivery of the postmature child before it becomes sufficiently large to cause dystocia by its mere size.

In *contracted pelvis,* premature labor is induced with the idea that the imperfectly developed child will be born more readily than at term. This view is undoubtedly correct, and if the welfare of the mother alone were concerned, the operation should frequently be undertaken. We know that labor will be easier the earlier the operation is performed, but it must be remembered that the child will be less liable to survive, and, even if born alive, its chances of succumbing to complications after its birth will be proportionately greater. Inasmuch, then, as the outlook for the child is better the later the operation is performed, the induction of premature labor should not be attempted before the thirty-fourth, and preferably not before the thirty-sixth, week of pregnancy.

The question as to the propriety of the operation has given rise to an extensive literature, but with increasing knowledge as to the course of labor in contracted pelves, together with the generally good results following cesarean section, a marked change in sentiment has occurred, and the induction of labor has lost greatly in popularity.

It is now generally recognized that from 70 to 80 per cent of all labors complicated by contracted pelvis will end spontaneously if treated expectantly. With this fact in mind, Pinard, Bar, Krönig, myself, and others hold that the induction of premature labor is rarely justified, and that in cases of moderate pelvic contraction equally good results for the mother, and far better results for the child, will be obtained by abstaining from it, and subjecting to cesarean section at term all patients who present such disproportion between the size of the head and the pelvis as makes a spontaneous outcome unlikely.

The principal difficulty connected with the induction of labor in such cases is to recognize those which will require it, and to choose the correct time for its performance. Unfortunately, we are unable to determine accurately the size of the child's head, and more particularly its degree of compressibility and ossification. The methods of Müller, Ahlfeld, and others, to which reference will be made in the chapter upon the treatment of contracted pelves, do not lead to very accurate results, so that the operation is frequently performed unnecessarily.

The results obtained are satisfactory so far as the mother is concerned, the maternal mortality being only 1.03 per cent in 391 operations reported by

Ahlfeld, Bar, Leopold, and Pinard. On the other hand, the fœtal mortality is relatively high, varying from 12 to 45 per cent. Kleinwächter, after an exhaustive study of the subject, concludes that 78.3 per cent of the children are born alive, but that only 60.4 per cent leave the hospital in good condition, which means a possible mortality of 39.6 per cent. Furthermore, when we consider that careful nursing and appropriate feeding are afterward necessary, it is apparent that no inconsiderable portion of the children dismissed from the hospital in good condition must inevitably perish within the first year, and it is hardly an exaggeration to state that scarcely one half of those born alive survive that period. It would, therefore, appear that the ultimate results, so far as the children are concerned, are so poor as not to commend the operation to favorable consideration, and that equally good results would be obtained by treating all cases expectantly, and performing craniotomy whenever operative delivery became necessary. As such a course would be a *reductio ad absurdum,* it follows that the operation should be abandoned. In my entire experience, I have employed it in only one case of contracted pelvis, and have no cause to regret my action. It must, however, be admitted that all authors do not share this view, as others contend that their results are fairly satisfactory.

The most usual indication for the operation, however, is afforded by diseases which threaten the life of the mother, while at the same time there exists a probability of cure after the termination of gestation. This is particularly true in those cases of preëclamptic *toxemia* or *chronic nephritis* complicating pregnancy, which show no tendency to subside in spite of appropriate treatment. Experience teaches that in such circumstances, even if pregnancy be allowed to continue, premature labor frequently occurs spontaneously, when a large proportion of the children are born dead, or, if alive, they are imperfectly developed. Accordingly, if threatening symptoms supervene, labor should be induced at any period of pregnancy without too conservative a regard for the life of the child, as the ideal method of treating eclampsia is to prevent its occurrence.

Cardiac lesions occasionally demand the induction of premature labor, but this should be resorted to only in cases of broken compensation, which do not yield to appropriate treatment. In many instances, more radical intervention by means of cesarean section followed by sterilization is preferable.

From the time of D'Outrepont (1828), it has been recommended that the operation be undertaken in the interests of the child in the rare cases of *tuberculosis* in which the condition of the mother is so serious as to make it probable that she will not live until term.

Spontaneous interruption of pregnancy frequently occurs during the course of the acute infectious diseases—influenza, pneumonia, typhoid fever, etc.—but inasmuch as experience has shown that it materially increases the risks to the mother, the induction of premature labor is contra-indicated.

In rare instances a general peripheral *neuritis* may so endanger the life of the mother as to call for interference. Lepage and Sainton reported a case of alcoholic origin in which the induction of labor was followed by happy results.

The milder forms of *chorea* complicating pregnancy are usually amenable to treatment, but when the disease assumes a grave type it is attended with great danger, the maternal mortality, according to Fehling, being 36 per cent. Therefore, if the patient appears to be in serious danger, premature delivery should be brought about, as experience has shown that the emptying of the uterus is sometimes followed by pronounced improvement.

In patients suffering from true *diabetes,* gestation sometimes exerts a very deleterious influence upon the course of the disease. Usually, however, the diabetic patient improves during the latter part of pregnancy, supposedly as a result of the activity of the fœtal pancreas. Thus, several of our patients, who had been followed for a number of years, were sugar-free while upon a normal diet during the last months of pregnancy and early in the lactation period; whereas, at all other times it was difficult to keep them sugar-free by most vigorous dieting. For these reasons, the induction of premature labor is rarely indicated, and, when carried out, rarely does good.

According to Graefe and Winter, the occurrence of pregnancy in patients suffering from *pernicious anemia* or leukemia adds markedly to the gravity of the condition, so that in occasional cases the induction of premature labor may be indicated.

In patients suffering from pyelitis, the pregnant uterus may so compress the ureter as to cause a damming back of the purulent discharge, and thus give rise to a *pyelonephrosis.* In such circumstances the induction of premature labor is indicated. Fortunately, however, such interference is rarely necessary, as with rest in bed and appropriate dietary and medicinal treatment the results are surprisingly good.

Formerly the induction of premature labor was recommended when pregnancy is complicated by *uterine* or *ovarian tumors,* or by malignant disease of the uterus or rectum, which would offer an insuperable obstacle to the birth of a full-term child. At the present day, however, such indications are not tenable. What has already been said in connection with the induction of abortion under similar conditions also holds good here.

In *hydramnios,* when the abdomen is so distended as seriously to threaten the life of the patient, pregnancy should be terminated without too much regard for preservation of the child, as in many such cases it is either so poorly developed or actually deformed as to have but little chance of living, even if born alive.

Whenever *placenta prævia* is positively diagnosed, the termination of pregnancy is urgently indicated, as it is impossible to predict at what moment uterine contractions may come on and give rise to profuse or even fatal hemorrhage.

In rare cases of *habitual death of the fœtus* in the later months of pregnancy, when not due to syphilis or renal disease, the induction of premature labor at a time slightly anterior to that at which fœtal death had occurred in previous pregnancies, sometimes results in the birth of a living child. In such cases, however, the intervention should be regarded merely as a justifiable experiment, and no assurance of success should be given.

One of the most important and defensible indications for the induction of labor is afforded by the so-called postmature child. Whenever during the last weeks of pregnancy palpation shows that the child exceeds the usual limits of size, and particularly in multiparæ who give a history of dystocia resulting from excessive bulk of the child, labor should be induced, as it appears irrational to allow conditions predisposing to serious dystocia to develop without intervention.

The same holds good in cases of prolonged pregnancy, and the physician should make it a rule to examine each week every patient whose history indicates that the calculated duration of gestation has been exceeded. Ordinarily, the child will be found normal in size, but when its development appears to be excessive or disproportion begins to develop, labor should be induced immediately.

As such indications are in great part dependent upon one's personal judgment, the greatest care should be exercised in arriving at a decision, and interference practiced only when clearly demanded by the physical findings. The induction of labor by operative means at a fixed date merely to suit the convenience of the patient or obstetrician cannot be reprehended too strongly, and should the outcome in such a case be unfavorable, nothing could be said in its defense. On the other hand, there is no objection to attempting to bring on labor by the administration of castor oil and quinine, either alone or in association with the nasal application of pituitrin, whenever the estimated date of confinement has passed and the patient is upset by the delay, as in my experience a successful result rarely follows unless Nature has about completed her task.

Prognosis.—As far as the mother is concerned, the prognosis of the induction of premature labor is excellent, provided a rigorous aseptic technic is observed and the physical condition is not critical at the time of the operation.

The prognosis for the child depends, of course, upon the degree of its development, as well as upon the pathological condition for which the operation is undertaken. Generally speaking, in the case of children born before the thirty-second week, the chances of surviving are small, especially when nephritis or hydramnios affords the indication for interference.

Methods of Inducing Premature Labor.—These may be medicinal or operative in character. The former are available only during the very last weeks of gestation, while the latter may be employed at any time after the child is viable. For this reason, the chief indications for attempting induction by medicinal means are afforded by the postmature child or by prolongation of pregnancy, and in such circumstances, it should always be employed before resorting to operative procedures.

For years castor oil and quinine have been administered for this purpose, but the results have been so uncertain that when a positive outcome follows, one is usually in doubt whether to ascribe it to the treatment or to the coincident onset of spontaneous labor. Watson supplements the castor oil and quinine by the administration of pituitary extract, and has developed the following technic which he claims is very effective:

6 P.M. castor oil 1 ounce
7 P.M. quinine 10 grains
8 P.M. large soap-suds enema
9 P.M. quinine 10 grains
12 P.M. quinine 10 grains

If pains have not supervened by nine o'clock the next morning, one-half cubic centimeter of pituitary extract is administered hypodermically, and repeated each half hour until labor sets in, or until six doses have been administered. Scott reported a successful result in 91 per cent of 198 personal cases, but regards the dosage of pituitary extract recommended by Watson as too high.

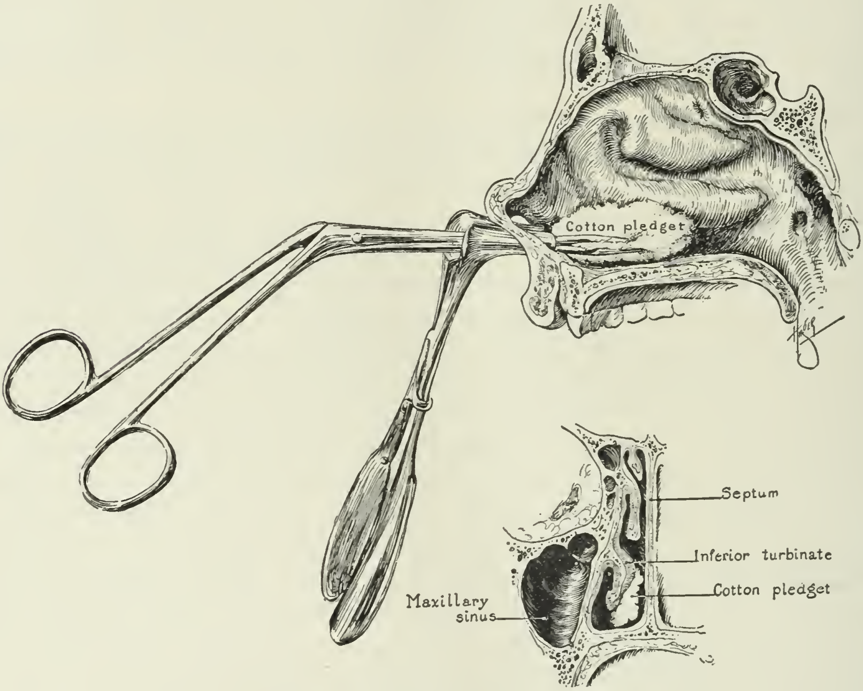

FIG. 361.—NASAL ADMINISTRATION OF PITUITRIN (Hofbauer).

Occasionally, when only two or three minims of pituitary extract are administered hypodermically, the uterus may go into tetanic contraction, which persists for some minutes, and when relaxation occurs the fœtal heart beat, which was previously audible, can no longer be heard. After having lost several children in such circumstances, I abandoned Watson's method for the induction of labor until Hofbauer, in our clinic, demonstrated the effectiveness of the nasal application of pituitary extract. He showed when a gauze pledget soaked in 1 cubic centimeter of it is introduced beneath the inferior turbinated bone and left in place a few minutes, that the physiological effects of the drug became apparent, and are quite as efficient in stimulating the uterus as when given hypodermically. The method possesses the great advantage that the absorption of the drug is relatively slow, and what is more important, that it can be immediately interrupted by withdrawing the pledget from the nose whenever the uterine action becomes too violent.

In our hands this method has the desired result in approximately three out of four women near term, but is almost valueless earlier in pregnancy, except in those suffering from toxemia, in whom the uterus seems more susceptible to stimulation. Castor oil and quinine are administered just as in Watson's method, and the first pledget is applied three hours after the last dose of quinine, and reapplied at half hourly intervals until efficient contractions supervene or until six applications have been made without effect. As the method has no deleterious effects upon the child, I formerly employed it freely.

The simplest operative method of inducing labor is that of Scheele, which consists in perforating the membranes with a sharp instrument and allowing the amniotic fluid to drain off. The results, however, are uncertain, so that the procedure is applicable only in a limited number of cases, more especially in hydramnios and in marginal placenta prævia.

In 1928, my former associate, J. M. Slemons, called my attention to the excellent results which follow artificial rupture of the membranes after the administration of castor oil and quinine, and since then I have made extensive use of it. The technic is as follows: The castor oil, quinine and enema are given as described above, and if pains have not supervened by the end of 6 hours, the membranes are ruptured artificially by means of a tenaculum—being preceded by slight dilatation of the cervical canal whenever it is not patulous enough to admit the finger tip. In nineteen cases out of twenty, labor sets in within a few hours and usually progresses unusually rapidly; while in the exceptional case in which this does not occur, the subsequent administration of pituitary extract is almost invariably followed by the desired result. Our experience with this method has been so satisfactory, that it has entirely supplanted the original Watson technic, and to a very great extent the intranasal application of pituitary extract. This method of inducing labor at or near term is without danger to mother or child provided the head is engaged, but it should always be borne in mind that when the head is floating the possibility of prolapse of the cord must always be reckoned with.

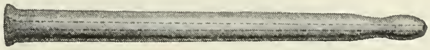
Fig. 362.—Wales' Bougie. × 1/6.

In the operative method most usually employed earlier in pregnancy—that of Krause—a bougie is introduced between the membranes and the uterine wall. In carrying out this procedure the patient is placed in the dorsal or Sims's position, and the external genitalia carefully disinfected. The cervix is then brought into view by means of a speculum, and one or more sterilized bougies are passed through it and gently carried high up into the uterine cavity, between the membranes and the uterine wall. I prefer the very thick-walled Wales' rectal tubes made by the Goodrich Company. These come in various sizes, the largest being 2 centimeters in diameter, and, while flexible, are sufficiently stiff to be introduced without the aid of a stylet.

The only objection to Krause's method is its uncertainty, but by employing the largest bougie possible we obtained successful results in 82.5 per cent of a series of 160 attempted inductions. In many cases the introduction of the bougie is followed within a few hours by uterine contractions, which lead to the expulsion of the fœtus after a longer or shorter period. Occasionally, however, twenty-four hours may elapse without the appearance of pains. In the latter circumstances the bougies should be removed, and the uterus left alone for 48 or 72 hours, after which the pregnancy is terminated in some other manner. I attach the greatest importance to this precaution, for, if it is not observed, serious infection may follow. Notwithstanding these shortcomings, when haste is not essential, this is the safest and best method of terminating pregnancy prior to the last few weeks.

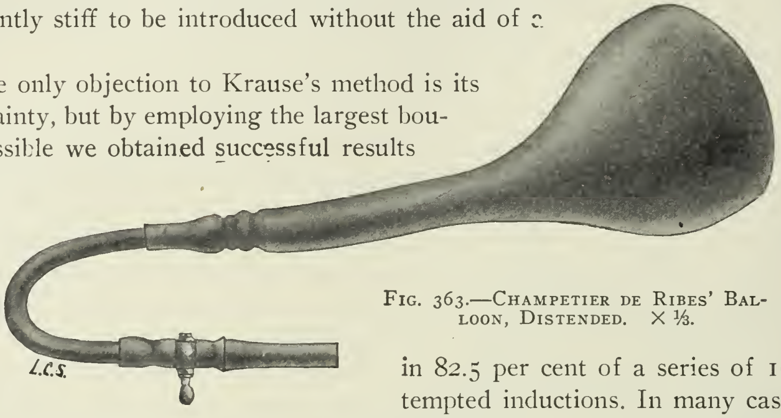

Fig. 363.—Champetier de Ribes' Balloon, Distended. × ⅓.

More rapid results are obtained by the use of inflatable rubber balloons. Those of Champetier de Ribes and of Vorhees are the most popular types. Both are conical rubber bags, from whose small end extends a thick rubber tube whose lumen can be closed by means of a stopcock or compression clamp. The walls of the former are reënforced, while those of the latter consist of plain rubber. They are made in several sizes, the largest measuring 10 centimeters in diameter at its top. If the cervical canal is 1.5 centimeter in diameter, the bag can be passed without difficulty; but if smaller, it should be dilated up to that size by means of a suitable dilator. The bag, which has been sterilized by

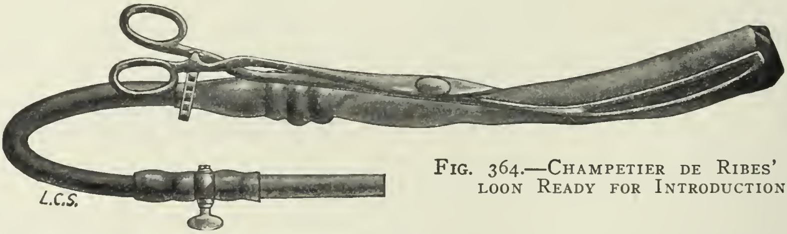

Fig. 364.—Champetier de Ribes' Balloon Ready for Introduction.

boiling, is tightly rolled into cylindrical form, seized with an appropriately shaped forceps, thickly smeared with sterile vaseline, introduced into the lower uterine segment, and then pumped full of sterile salt solution. Within a few hours it usually so irritates the uterus as to induce contractions, which soon lead to dilatation of the cervix and the expulsion of the bag, after which the child can be extracted or labor allowed to end spontaneously, according to the exigencies of the case. Where greater haste is necessary, the dilatation may be accelerated by attaching a weight to the end of the tube and allowing it to hang over the foot of the bed.

The induction of labor by means of the bag is more rapid and slightly more efficient than by means of the bougie, but at the same time it suffers from several disadvantages. In the first place, anesthesia is usually essential, and the greater manipulation required for its introduction, definitely increases the possibility of infection. More important, however, is the fact that the presence of the bag in the lower uterine segment inevitably displaces the presenting part and predisposes to rupture of the membranes, with the result that when the bag is expelled spontaneously or is removed malpresentation of the child or prolapse of the cord frequently follow. Morton showed in 1929 that the latter accident occurred in 17.4 per cent of our cases in which labor was induced for other indications than placenta prævia, with the result that the fœtal mortality was more than twice as great as when the bougie was employed. For these reasons, I employ the latter by preference in all inductions where haste is not essential, but in the last weeks of pregnancy I do not resort to either method until after castor oil, quinine and rupture of the membranes have proved ineffectual.

When the cervix is but slightly dilated, certain authorities recommend the use of a sterile tampon. In such cases the cervix is exposed by means of a speculum, and the end of a sterilized 4-inch roller gauze bandage is tightly packed into its canal by means of a uterine dressing forceps, after which the vagina is firmly and tightly packed with the same material. The pack should be removed within twelve hours, and at the expiration of that period the cervix will often be found sufficiently dilated to permit of other maneuvers. Generally speaking, I advise against its use, for, in addition to being uncertain in its action, it is sometimes followed by infection even when introduced under the most rigid aseptic precautions.

Numerous other methods for the induction of premature labor have been suggested from time to time, among which may be mentioned that of Pelzer, which consists of the injection into the uterine cavity of 100 cubic centimeters of glycerin, which is promptly followed by uterine contractions. Its employment, however, is not to be recommended, as it is occasionally followed by serious symptoms of intoxication, hemoglobinuria, albuminuria, elevation of temperature, cyanosis, and occasionally by death. Full details respecting the various other methods suggested for the induction of premature labor will be found in the monographs of Kleinwächter, Fieux, and Williamson.

Accouchement Forcé.—By this term is understood the forcible dilatation, or clean-cut incision, of the intact or partially dilated cervix, followed by the immediate delivery of the child. In pre-antiseptic times the operation was so universally followed by infection that it naturally fell into deserved disrepute; but it has since been rehabilitated, and when properly performed under suitable conditions has been the means of saving many lives. An excellent *résumé* of the history of the operation will be found in the dissertation of Ruhemann. Generally speaking, if the cervix be firm and hard and the canal not obliterated, forcible dilatation is apt to be very difficult and attended with considerable risk to the mother, so that its resistance had better be overcome by a cutting operation. On the other hand, when the cervical canal is obliterated and resistance is offered only by the partially dilated external os, rapid dilatation is readily performed, although it is usually accompanied by more or less deep cervical tears, whose extent is sometimes out of all proportion to the force employed. Naturally, it is more difficult in primiparous than in multiparous women.

Indications.—Until recently, the most usual indication for accouchement forcé in this country was threatened or actual eclampsia, but it is no longer employed, as better results are obtained by more conservative means. Occasionally it becomes necessary in concealed or accidental hemorrhage, or in other conditions which threaten the life of the mother or child, such as acute edema of the lungs, broken cardiac compensation, or in exceptional cases of prolonged labor in which the life of the child is endangered. It should, however, not be employed in placenta prævia.

Manual Dilatation.—If labor has already begun, the cervical canal is obliterated, and the resistance is offered only by the external os, which is five or more centimeters in diameter, excellent results are obtained by the method of manual dilatation suggested by Philander A. Harris. But if labor has not set in, and

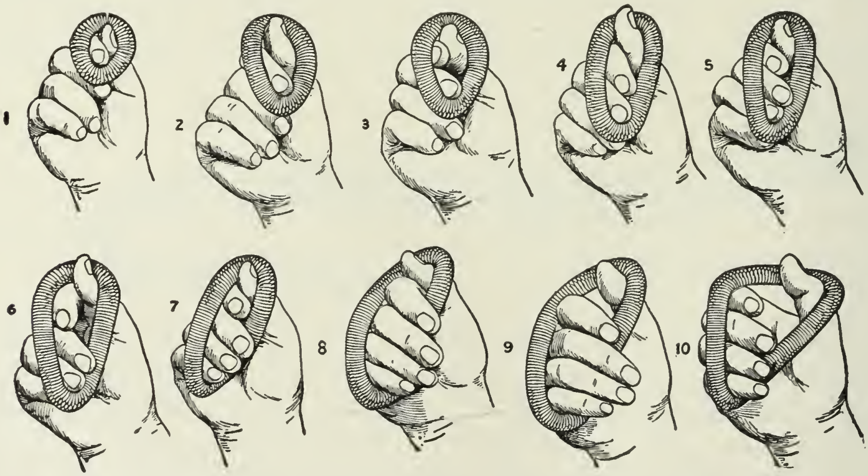

Fig. 365.—Diagrams Illustrating Manual Dilatation of Cervix (Harris).

the cervix is intact and hard and rigid, the operation is both difficult and dangerous; and if the attempt at dilatation be forcibly persisted in, it gives rise to deep tears through the cervix, and occasionally through the lower uterine segment as well, which may lead to the death of the patient from hemorrhage or infection. Generally speaking, if rapid delivery is urgently demanded under such conditions, it should be effected by vaginal hysterotomy, or by cesarean section.

At the time of operation the patient should be profoundly anesthetized and the most rigorous aseptic technic applied. After ironing out the vaginal opening and the pelvic floor by the thoroughly lubricated hand, the index finger is carried through the internal os, and followed as soon as possible by the second finger. When this has been accomplished, completion of the dilatation is usually comparatively easy. The dilating force is exerted by the back of the thumb, which is pushed past the index finger with much the same motion as is employed in snapping one's fingers; then, as dilatation progresses, two, three, and finally all four fingers are employed. These maneuvers are clearly shown in Fig. 365.

When the cervical canal is already obliterated, complete dilatation of the external os can be readily effected by Harris's method within half an hour. Formerly, I employed the method frequently, but for years I have used it less and less, as I have found even when the external os is 5 centimeters in diameter and presents thin margins, that attempts at complete dilatation are always associated with laceration, whose extent cannot be controlled. Its use is especially contra-indicated in placenta prævia on account of the increased liability to deep cervical tears, and even to rupture of the uterus.

Furthermore, the operator should bear in mind that the liability to laceration is greater the more rapidly dilatation is effected, and he should therefore be careful to avoid undue haste. This caution is the more necessary, as there seems to be an irresistible tendency to overestimate the time consumed in the process, and from my own experience I know that what may seem to be a long time to the operator is often in reality only a few minutes. For this reason, it is always well to control the rapidity of dilatation by watching the clock, as in such circumstances one should judge of the excellence of an obstetrician by the deliberation, rather than by the rapidity, with which he operates.

Edgar and Bonnaire have described bimanual methods of dilatation, which they claim give most satisfactory results. I have not employed them, and therefore cannot express a personal opinion as to their merits. On general principles it may be assumed that they are effective, but also afford somewhat greater opportunity for infection from the rectal contents, since both hands are used and therefore must come into more intimate contact with the anal region than in Harris's method. According to Delmas, all methods of cervical dilatation are greatly facilitated by the use of spinal anesthesia, but I have had no experience with its use in this connection.

Whatever method of manual dilatation is employed, one should always suspect that it has given rise to lacerations. Accordingly, after delivery has been effected, the cervix should be exposed by the aid of a posterior retractor and thoroughly inspected and any serious tear immediately repaired. If such a precautionary inspection is made as a matter of routine, one will be surprised at the frequency and extent of cervical tears, and will learn to hesitate to make use of manual dilatation unless it is urgently necessary.

Dilatation by Means of Champetier de Ribes's Balloon.—Whenever haste is not a great consideration, this is the ideal method of accouchement forcé, and should be employed whenever possible. It is particularly indicated in cases of placenta prævia, and will be referred to more fully under that head. The literature upon the subject was well reviewed by Bürger in 1906.

Instrumental Dilatation.—Various instruments have been devised to effect the rapid and complete dilatation of the cervical canal, but to my mind none of them is satisfactory.

Leopold, in 1902, introduced into Germany the use of Bossi's powerful dilator, which was first employed by its inventor in 1889. This consists of four heavy blades, arranged as compound levers and operated by a screw handle. Leopold was most enthusiastic concerning it, and his hearty indorsement led to its trial, in various modifications, in all parts of the world; but the final verdict is that it is a most dangerous instrument.

I have had no experience with it; for, while there can be no doubt as to its dilating power, it seems to me that its sphere of usefulness is very limited. If the cervix is undilated and rigid, its employment is unjustifiable; whereas, on the other hand, when the resistance of the internal os has already been overcome, equally satisfactory results may be obtained by other methods. Moreover, if cervical tears cannot be entirely avoided in manual dilatation, in which the resistance of the cervix can be accurately gauged by the operating hand, they must occur far more frequently when the dilating force is applied more or less blindly by means of a powerful steel compound lever. It is interesting to note that a similar instrument was devised in 1892 by H. S. Lott, of Salem, N. C., quite independently of Bossi's invention.

Deep Cervical Incisions.—When rapid delivery is urgently indicated in cases in which the cervical canal is obliterated but the external os not fully dilated, Dührssen recommended, in 1890, that multiple incisions be made through the vaginal portion of the cervix, which are united by sutures after the completion of labor. The technic of the operation is comparatively simple, as three incisions, roughly corresponding in location to the hours II, VI and X of the face of a clock, are made by means of scissors. The procedure is freely employed in Germany, but only occasionally in this country, as one is apprehensive of further tearing of the incisions as the child is extracted, with resulting deep cervical lacerations, which may give rise to profuse hemorrhage and prove difficult to repair.

Vaginal Cesarean Section.—This operation, which is better designated as vaginal hysterotomy, was first described by Dürhrssen in 1896, but did not come into general use for some years later on account of the polemical manner in which its inventor urged its claims.

In my opinion it affords a satisfactory method for rapidly terminating pregnancy at any time prior to the last month whenever the cervix is undilated and rigid, and is far superior to brutal attempts at manual or instrumental dilatation. Unfortunately, it requires some surgical skill on the part of the operator, as well as specially devised specula, and the aid of several competent assistants, so that its use must be limited to trained specialists.

After the usual preparations for operation, a heavy traction suture is introduced through either side of the cervix. The latter is then drawn down as near as possible to the vulva, and a longitudinal incision made through the anterior vaginal wall from a little below the urethra to the external os (Fig. 366). The bladder is then separated from the anterior surface of the cervix and lower uterine segment by means of a finger covered by a piece of gauze. The first part of the separation is done by touch alone, but later a large retractor, with a blade measuring 5 × 12 centimeters, is introduced into the wound, after which the process is completed under the guidance of the eye, the bladder being drawn up behind the retractor, when the entire wall of the uterus, from the anterior lip of the cervix to the contraction ring, is freely exposed. The anterior wall of the cervix and lower uterine segment is then incised for a distance of about 10 centimeters by means of a pair of heavy scissors (Fig. 367), and, after removing the speculum, the hand is introduced into the uterus, ruptures the membranes, and turns the child. After its extraction and the expression of the

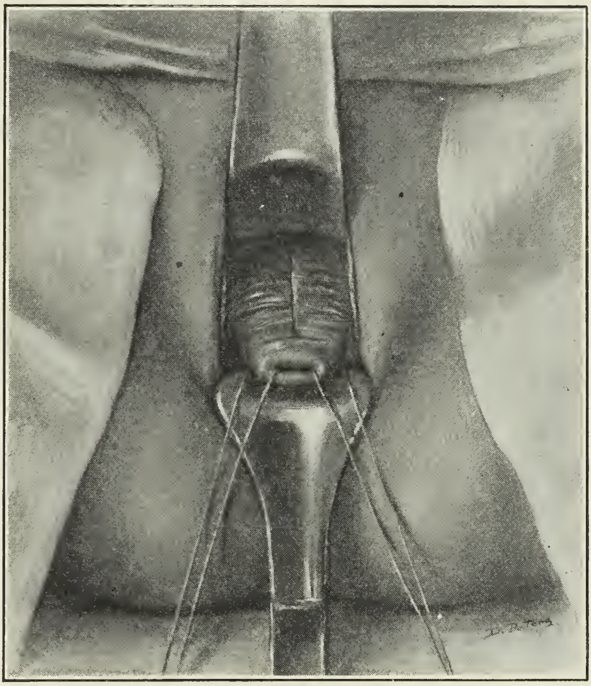

Fig. 366.—Vaginal Cesarean Section. Exposure of Cervix and Primary Incision.

placenta, the speculum is again introduced, and, by making the traction sutures taut, the entire uterine wound becomes visible as a triangular opening. Its edges are then united from above downward by interrupted catgut sutures, which are introduced under the guidance of the eye, after which the vaginal incision is closed by a continuous catgut suture (Fig. 368).

The anterior incision affords sufficient space for the extraction of the child up to the eighth month of pregnancy, but after that period a posterior incision is also necessary. In this event, the operation is begun by making a transverse incision in the posterior fornix at the cervical junction, and peeling off the peritoneum from the posterior wall of the cervix and lower uterine segment, which is then incised for a distance of 5 centimeters, after which the anterior wall is treated as has been described. The necessity for the double incision is readily understood, when one recalls that the suboccipitobregmatic circumference of the fully developed head measures 32 centimeters, so that if only an anterior incision is made, it must measure 15 to 16 centimeters in length to permit the passage of the head without laceration of its upper end, which would necessitate opening the peritoneal cavity; whereas if the incisions are double, each requires to be only half so long. In the latter event, the posterior wound should be closed first.

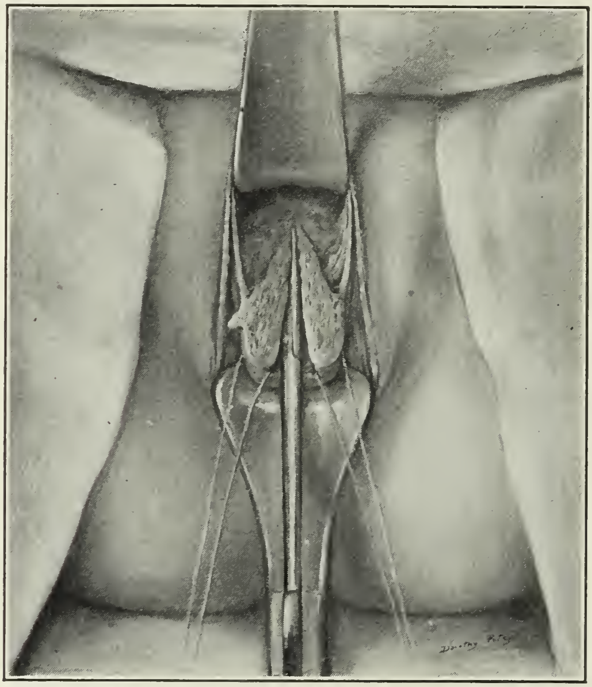

FIG. 367.—VAGINAL CESAREAN SECTION. INCISION OF ANTERIOR UTERINE WALL AFTER SEPARATION OF BLADDER.

In competent hands vaginal hysterotomy permits the delivery of the child in a few minutes, no matter what the condition of the cervix, and the entire operation requires less than thirty minutes for its completion. Its advantages over manual or instrumental dilatation are that it leaves a clear-cut wound, properly united by sutures, in place of an irregular, deep, cervical laceration, which may extend into the lower segment, and which frequently cannot be properly repaired. If the incisions are made in the median line, the amount of hemorrhage is surprisingly small, and, if a suitable large retractor is employed, every step of the operation is readily visible.

I consider that the difficulties which are sometimes encountered in its performance are usually due to two factors: first, that the speculum employed is too small to give a suitable exposure of the field of operation; second, that the incision is either too short or not in the midline of the uterus. In the latter event profuse hemorrhage may occur, either as the result of laceration of the upper end of the incision during extraction of the head, or because the incision lies to one side of the midline. Dührssen showed that there was a tendency to relaxation of the uterus after the operation, and advised that the cavity be packed with gauze as a prophylactic against such an accident. I believe that this is a wise precaution, and always introduce the pack before laying the sutures in the anterior wall.

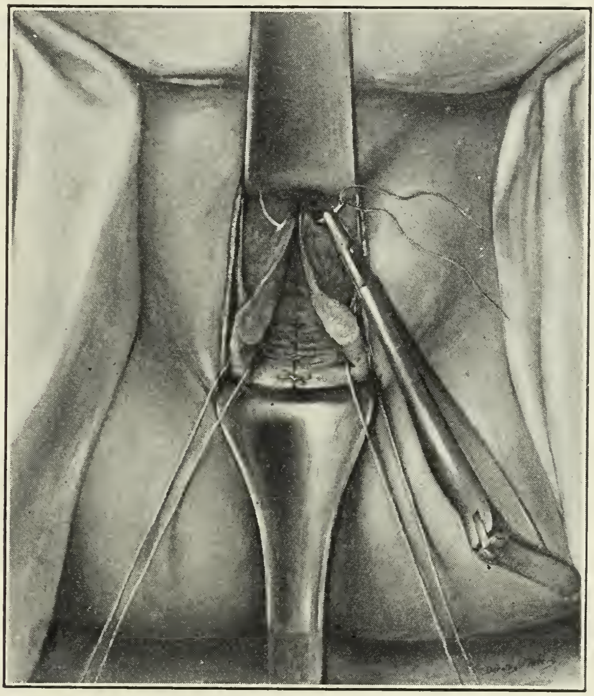

FIG. 368.—VAGINAL CESAREAN SECTION. LAYING OF SUTURES IN ANTERIOR INCISION. POSTERIOR INCISION ALREADY SUTURED.

Dührssen, in 1909, stated that the technic of the operation could be simplified by introducing a medium-sized rubber balloon into the uterus, which, after being filled tightly with sterile salt solution, is used as a tractor, the anterior wall of the cervix and lower uterine segment being incised over it until it slips out.

A full account of the operation, together with a list of all the cases of vaginal hysterotomy reported up to 1905, will be found in Dührssen's article in Winckel's Handbuch der Geburtshülfe. My own favorable opinion is based upon a considerable number of operations; although I now rarely employ it late in pregnancy, for the reason that I treat patients suffering from eclampsia, which was the most usual indication for its use, much more conservatively than formerly. On the other hand, I consider it the ideal method of ending early pregnancy whenever haste is imperative and the cervical canal is too rigid to permit easy dilatation. Peterson advocates it enthusiastically, and Winter reported that the mortality was only a trifle over 1 per cent in 446 cases which he collected from the literature in 1909.

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CHAPTER XX

FORCEPS

The obstetrical forceps is an instrument designed for the extraction, under certain conditions, of the child when it presents by the head. It consists of two branches which cross one another, and are designated right and left, respectively, according to the side of the pelvis to which each corresponds. They are introduced separately into the genital canal and are articulated after being placed in position. Each branch is made up of four portions—the blade, handle, shank, and lock.

The instruments vary considerably in size and shape, as will be seen when certain varieties of forceps are considered. The blades possess a double curvature—the cephalic and the pelvic—the former being adapted to the shape of the child's head, the latter to that of the birth canal. The blades are more or less elliptical in shape, tapering toward the shank, and are usually fenestrated so as to allow of a firm hold upon the head. Certain authorities, however, prefer solid blades in the belief that they can be made less bulky.

The cephalic curves should be such as to permit the head to be grasped firmly, but without serious compression. The greatest distance between the two blades should not exceed 7.5 centimeters (3 inches), when they are articulated. The pelvic curve corresponds more or less to the axis of the birth canal, but varies considerably in different instruments. When the forceps is placed upon a plane surface, the tips of the blades should be about 8.8 centimeters (3½ inches) higher than the handles. The latter are connected with the blades by the shanks, which give the requisite length to the instrument.

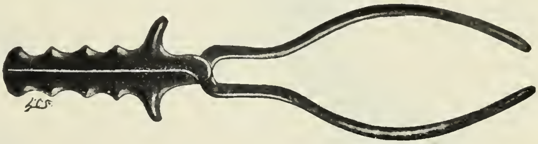
Fig. 369.—Simpson's Forceps, Cephalic Curve.

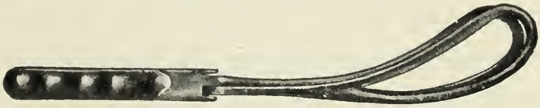
Fig. 370.—Simpson's Forceps, Pelvic Curve.

The two branches articulate at the lock, which varies widely in different instruments. The English type consists of a socket upon each branch, into which fits the shank of the other half of the instrument. This arrangement permits of ready articulation, but does not hold the blades firmly together. In the French lock a pivot is screwed into the shank of the left branch, while the right presents an opening which can be adjusted to it, the screw being tightened after articulation. The German lock is a combination of the two, the shank of the left branch bearing a pivot with a broad, flat head, while the right is provided with a notch which corresponds to the pivot. When the instrument is properly articulated the handles should fall together in such a way as to be conveniently grasped by one hand of the operator.

History.—Crude forceps were in use from an early period, several varieties having been described by Albucasis, who died in 1112; but, as their inner surfaces were provided with teeth intended to penetrate the head, it is evident that they were intended for use only upon dead children.

The true obstetrical forceps was devised in the latter part of the sixteenth, or the beginning of the seventeenth century, by a member of the Chamberlen family. The invention, however, was not made public at the time, but was preserved as a family secret through four generations, and did not become generally known until the early part of the eighteenth century. Prior to that time version had been the only method which permitted the artificial delivery of an unmutilated child, and accordingly when that operation was out of the question and delivery became imperative, it was accomplished by means of hooks and crotchets, which usually led to the destruction of the child. Thus, before the invention of forceps, the use of instruments was synonymous with the death of the child, and frequently of the mother as well, and tended to bring obstetrics into disrepute.

William Chamberlen, the founder of the family, was a French physician, who fled from France as a Huguenot refugee and landed at Southampton in 1569. He died in 1596, leaving a large family. Two of his sons, both of whom were named Peter, and designated as the elder and younger, respectively, studied medicine and settled in London. They soon became successful practitioners, and devoted a large part of their attention to midwifery, in which they became very proficient. They attempted to control the instruction of midwives, and in justification of their pretensions claimed that they could successfully deliver patients when all others had failed.

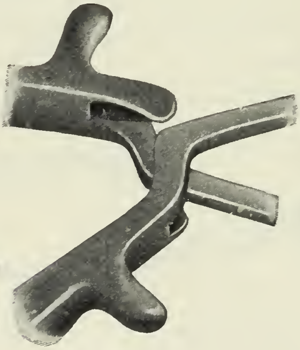

Fig. 371.—Lock of English Forceps.

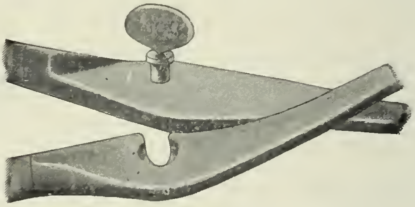

Fig. 372.—Lock of French Forceps.

The younger Peter died in 1626, and the elder in 1631. The latter left no male children, but the former was survived by several sons, one of whom, born in 1601, was likewise named Peter. To distinguish him from his father and uncle, he is usually spoken of as Dr. Peter, as the other two did not possess that title. He was well educated, having studied at Cambridge, Heidelberg, and Padua, and on his return to London was elected a Fellow of the Royal College of Physicians. He was most successful in the practice of his profession, and counted among his clients many of the royal family and nobility. Like his father and uncle, he attempted to monopolize the control of the midwives, but his pretensions were set aside by the authorities. These attempts gave rise to a great deal of discussion, and many pamphlets were written as to the morality of women in labor being attended by men, which he answered in a pamphlet entitled "A Voice in Ramah, or the Cry of Women and Children as Echoed Forth in the Compassions of Peter Chamberlen." He was a man of considerable ability, and united at the same time some of the virtues of a religious enthusiast with many of the devious qualities of a quack. He died at Woodham, Mortimer Hall, Essex, in 1683, the place remaining in the possession of his family until well into the succeeding century. Formerly he was considered the inventor of the forceps, but, as we now know, this view was incorrect.

He left a very large family, and three of his sons—Hugh, Paul, and John—became physicians, and devoted special attention to the practice of midwifery. Of these Hugh (1630-1706) was the most important and influential. Like his father, he possessed considerable ability, and at the same time took a practical interest in politics. Some of his views not being in favor, he was forced to leave England, and while in Paris, in 1673, attempted to sell the family secret to Mauriceau for 10,000 livres, claiming that by its means he could deliver in a very few minutes the most difficult cases. Mauriceau placed at his disposal a rachitic dwarf whom he had been unable to deliver, and Chamberlen, after several hours of strenuous effort, was likewise obliged to acknowledge his inability to do so. Notwithstanding his failure, however, he maintained friendly relations with Mauriceau, and on returning home translated the latter's book into English. In his preface he refers to the forceps in the following words: "My father, brothers, and myself (though none else in Europe as I know) have by God's blessing and our own industry attained to and long practiced a way to deliver women in this case without prejudice to them or their infants."

Some years later he went to Holland and sold his secret to Roonhuysen. Shortly afterward the Medico-Pharmaceutical College of Amsterdam was given the sole privilege of licensing physicians to practice in Holland, to each of whom, under pledge of secrecy, was sold Chamberlen's invention for a large sum. This practice continued for a number of years, until Vischer and Van der Poll purchased and made public the secret, when it was found that the device consisted of one blade only of the forceps. Whether this was all that Chamberlen sold to Roonhuysen, or whether the Medico-Pharmaceutical College had swindled the purchasers, is not known.

Hugh Chamberlen left a considerable family, and one of his sons—Hugh (1664-1728)—practiced medicine. He was a highly educated, respected, and philanthropic physician, and numbered among his clients members of the best families in England. He was an intimate friend of the Duke of Buckingham, and when he died the latter caused a statue to be erected in his honor in Westminster Abbey. During the later years of his life he allowed the family secret to leak out, and the instrument soon came into general use.

For more than one hundred years it was believed that the forceps was the invention of Dr. Peter Chamberlen, but in the year 1813 Mrs. Kembell, the housekeeper of a rich brewer who had purchased Peter Chamberlen's country house, found in the garret a trunk containing numerous letters and instruments, among the latter being four pairs of forceps, together with several levers and fillets. As is evident from the drawings, the forceps were in different stages of development, one pair being hardly applicable to the living woman, while the others were useful instruments. Aveling, who has carefully investigated the matter, believes that the three pairs of available forceps were used respectively by the three Peters, and that in all probability the first was devised by the elder Peter, son of the original William. Confirmation is lent to this view by the fact that Peter, on one occasion, at least, spoke of the invention of his uncle. Sänger and Budin, who have also investigated the subject, incline to the same belief.

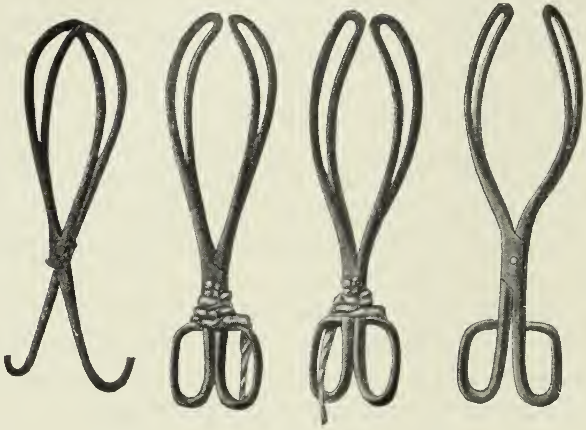

Fig. 373.—Chamberlen's Forceps.

The forceps came into general employment in England during the lifetime of Hugh Chamberlen, the younger. The instrument was used by Drinkwater, who died in 1728, and was well known to Chapman and Giffard. The former, writing in 1733, says: "The secret mentioned by Dr. Chamberlen was the use of the forceps, now well-known by all the principal men of the profession, both in town and country."

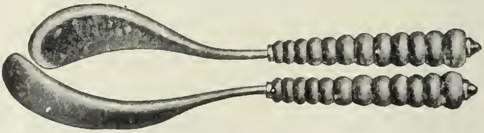

Fig. 374.—Palfyn's Forceps.

In 1723, Palfyn, a physician of Ghent, exhibited before the Paris Academy of Medicine a forceps which he designated as *mains de fer*. It was crude in shape and did not articulate. In the discussion following its presentation, De la Motte stated that it would be impossible to apply it to the living woman, and added that if by chance any one should happen to invent an instrument which could be so used, and kept it secret for his own profit, he deserved to be exposed upon a barren rock and have his vitals plucked out by vultures, little knowing that at the time he spoke such an instrument had been in the possession of the Chamberlen family for nearly one hundred years.

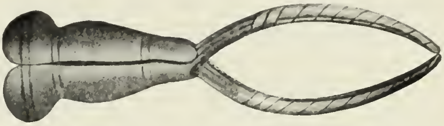

Fig. 375.—Smellie's Short Forceps.

The Chamberlen forceps was a short, straight instrument, which possessed only a cephalic curve, and is perpetuated in the short or low forceps of to-day. It was used, with but little modification, until the middle of the eighteenth century, when Levret, in 1747, and Smellie, in 1751, quite independently of one another, added the pelvic curve and increased the length of the instrument. Levret's forceps was longer and possessed a more decided pelvic curve than that of Smellie, and it is from these two instruments that the long forceps of the present day is descended—the long French forceps being the lineal descendant of the former, and that of Simpson of the latter.

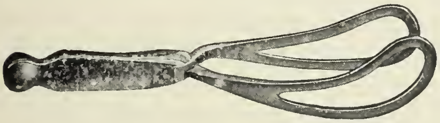

Fig. 376.—Short Forceps.

As soon as the forceps became public property it was subjected to various modifications, so that Mulder, in an atlas published in 1798, was able to give illustrations of nearly 100 varieties. Some idea of the desire to modify and improve the instrument may be gained by glancing at Witkowski's Obstetrical Arsenal, in which are pictured several hundred forceps, which, after all, constitute only a small portion of those devised. The monographs of Poullet and Das contain excellent historical sketches of the development of the instrument. But, considering all the work done, it is surprising how little advance was made over the instruments of Levret and Smellie, until Tarnier, in 1877, clearly enunciated the principle of axis traction, which has since revolutionized our ideas upon the subject.

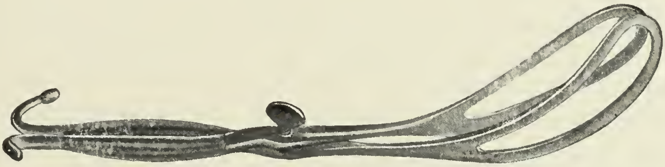

Fig. 377.—Long French Forceps (Levret).

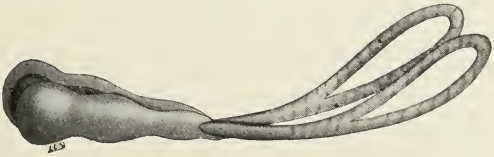

Fig. 378.—Smellie's Long Forceps.

Choice of Forceps.—Inasmuch as it would appear that in the past nearly every one interested in obstetrics has thought it necessary to attempt to modify the forceps, and to have an instrument bearing his own name, the young physician is likely to be embarrassed by the multitude from which he has to choose. Any properly shaped instrument will give satisfactory results, provided it be used intelligently, but for general purposes the ordinary Simpson forceps is probably the best, though, if one expects to do much obstetrical work, a Tarnier axis-traction forceps becomes essential. Personally I always employ the latter, using the traction rods or not, according to circumstances, as I believe it better to become thoroughly familiar with one instrument than to have several for use under different conditions.

The forceps should be entirely of metal, so that it can be readily sterilized by boiling.

Functions of the Forceps.—This subject has been considered in detail by Chassagny. The forceps may be used as a tractor, rotator, compressor, dilator, lever, or irritator.

Its most important function is traction, exercised for the purpose of drawing the head through the genital tract. In not a few cases, however, particularly in transverse and posterior occipital presentations, its employment as a rotator is attended by happy results. It should never be used primarily as a compressor, though of course it is impossible to make traction without subjecting the head to a slight degree of compression; but when it is desired to bring about a diminution in its size other instruments are more appropriate.

Particularly in the past, certain authors advocated applying the forceps through a partially obliterated cervix, and assisting dilatation by traction upon the head. Such a procedure, however, is unjustifiable, for, when delivery becomes necessary under such conditions, the cervix should be stretched manually, and forceps not applied until after dilatation has been completed.

In rare instances one blade of the forceps may be employed as a lever—the vectis, although at present use is very seldom made of this function. Before the use of anesthesia became general, great stress was laid on the so-called dynamic action of the forceps, by which is meant the irritation of the uterus which follows its introduction. But at present this function is of no significance.

Indications for the Use of Forceps.—Strictly speaking, the termination of labor by forceps, provided it can be accomplished without too great danger, is indicated in any condition which threatens the life of the mother or child, and which offers a reasonable prospect of being relieved by delivery. On the part of the mother, such conditions are eclampsia, heart lesions attended by broken compensation, acute edema of the lungs, hemorrhage from premature separation of the placenta, intrapartum infection, or exhaustion. Whenever there is question of interference for the last-named condition, definite objective symptoms should be present, the condition of the pulse being of especial importance; whereas, on the other hand, but little weight should be attached to the statements of the patient.

As regards the child, the operation may be called for by prolapse of the umbilical cord, premature separation of the placenta, undue pressure exerted upon the head, and especially by changes in the rhythm of the heart beat and the escape of meconium in vertex presentations. A fœtal pulse falling permanently below 100, or exceeding 160 to the minute, indicates that the child is in danger and may perish if not promptly delivered. In vertex presentations the discharge of amniotic fluid tinged with meconium usually indicates interference with the placental circulation and imperfect oxygenation, manifesting itself by paralysis of the sphincter ani. In breech presentations, on the other hand, the escape of meconium is without significance, being due merely to pressure exerted upon the child's abdomen.

In practice, however, the maternal indications for the use of forceps may be considerably extended, and in many instances the operation may be advisable in the case of women suffering from acute infectious diseases, heart lesions, or diseases of the respiratory tract, who must be saved as far as possible from the exhaustion incident to an unaided second stage of labor. Likewise, it is generally advisable to relieve the strain upon a cicatrix resulting from a previous cesarean section.

One of the most frequent indications is afforded by faulty contraction of the uterine or abdominal muscles, the forceps being utilized merely to reënforce the insufficient *vis a tergo*. Furthermore, in elderly primiparæ, the amount of resistance offered by the perineum and the vaginal outlet may sometimes be so great as to oppose a serious obstacle to the passage of the child, even when the expulsive forces are normal. In the absence of disproportion, it is a good practical rule to apply forceps if advance does not occur after two hours of satisfactory second stage pains, but if the head is upon the perineum and no progress has been made for one hour in spite of good pains, it is usually not advisable to wait longer. At the same time it must be insisted upon that the operation should never be performed to save the physician's time, nor to quiet the importunities of the patient's family, but only when distinctly indicated by the condition of the mother or child; so that, whatever the outcome may be, the conscience of the operator will be clear.

DeLee takes a more radical position, as he believes that prolonged pressure of the fœtal head against a more or less rigid perineum frequently results in serious injury to the cerebral tissues, and recommends the performance of what he designates as "the prophylactic forceps operation." In this procedure, as soon as the head rests firmly upon the pelvic floor and has begun to part the pillars of the levator ani muscle, a deep lateral incision is made through the perineal and vaginal tissues, which extends into the levator ani if the disproportion promises to be great, following which forceps are applied. He considers that prompt intervention adds greatly to the safety of the child, relieves the patient from a considerable part of the strain incident to the second stage of labor, and leaves her genitalia in such condition that the occurrence of outlet relaxation in the future is reduced to a minimum. In his skillful hands, these objects are no doubt accomplished, but I am confident that the results would be disastrous were his suggestion generally adopted.

The following conditions must be fulfilled before forceps can be applied with safety: (1) The child must present correctly; (2) the cervix must be fully dilated or dilatable; (3) the membranes must be ruptured; (4) there must be no considerable disproportion between the size of the head and the pelvis; and (5) the head must not be too small.

The child should present by the vertex or face, and an accurate diagnosis be made as to the position and variety, forceps not being available when the chin is directly posterior. The forceps is not applicable to shoulder presentations, nor is it intended to be applied to the breech. Generally speaking, it should not be employed in brow cases until after conversion into a vertex or face presentation has been brought about.

The cervix must always be completely dilated before the application of forceps, offering a diameter of from 9 to 10 centimeters. Of course it is possible to apply the blades through a canal measuring only 4 or 5 centimeters, but in such circumstances the cervical ring offers marked resistance, and, if the head be dragged through it, great resistance may be encountered, and deep tears result, which may also implicate the lower uterine segment. Accordingly, if prompt delivery becomes imperative under such conditions, complete cervical dilatation should be effected manually before forceps are applied. On the other hand, if the head is only partially engaged, or is floating above the superior strait, delivery is best effected after podalic version provided the uterus is not too tightly contracted and serious disproportion does not exist.

The membranes should always be ruptured before applying forceps, for, if they intervene, the grasp upon the head is not so firm, and, what is more important, traction upon them may occasionally bring about premature separation of the placenta.

Failure of engagement to occur is usually indicative of disproportion between the size of the head and the pelvis. Accordingly, before applying forceps in such circumstances, the size of both should be determined as accurately as possible, for if the head be unduly large, as in an excessively developed or hydrocephalic child, it cannot pass the superior strait. Generally speaking, contracted pelvis presents an absolute contra-indication to the application of forceps; for, if the contraction be marked, it will be impossible to drag the head through the pelvis, and the employment of brute force may result in the death of the child and severe injuries to the mother. On the other hand, when the contraction is but slight, and especially when the head is firmly engaged in the upper part of the pelvic cavity, the tentative application of forceps may be justifiable. Under such circumstances a few tractions of moderate intensity should be made; if the head follows they should be continued, but if not the forceps should be removed and delivery effected in some other manner.

On the other hand, forceps should not be attempted when the child is abnormally small, since the head cannot be properly grasped and the blades will slip off when traction is made. Similar contra-indications, likewise, apply when when the child is macerated.

Preparations for Operation.—When the application of forceps becomes necessary, either in the interests of the mother or child, the physician should inform a responsible member of the family of his decision. It is not advisable to inform the patient until the preparations for operation are completed.

Whenever possible, the patient should be placed upon a table of suitable height, as ordinary beds are too low and too soft for convenience. Anesthesia should always be employed, and whenever practicable its administration should be intrusted to a competent assistant, rather than to the nurse or some member of the family, since in the latter case a large part of the obstetrician's attention must of necessity be devoted to watching the general condition, instead of being concentrated upon the operation.

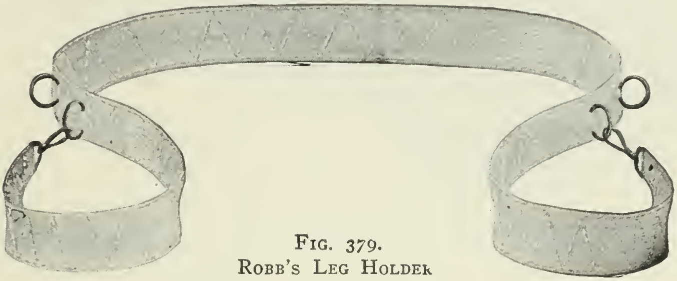

Fig. 379.
Robb's Leg Holder

When anesthesia is complete, the patient's buttocks should be brought to the edge of the table, and her legs held in position by an appropriate leg holder, or by stirrups. The former is particularly convenient in private practice, as it enables one to dispense with assistants for holding the legs. The patient is then prepared for operation, as is described on page 450.

Except when the outlet is greatly relaxed, it is advisable to dilate it manually as a preliminary procedure; as by so doing, the liability to perineal laceration is decreased, and less powerful traction is necessary. For this purpose, the hand is freely lubricated, and preliminary dilatation is effected by making downward and lateral traction with two fingers. Then the fingers, in the form of a cone, are given a rotary motion and slowly introduced into the vagina, gradually dilating it until the closed fist can pass the vulval outlet with

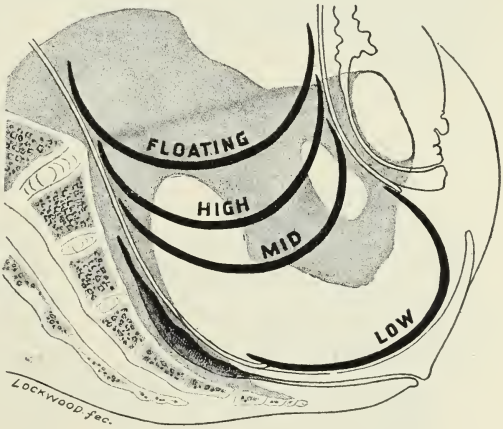

Fig. 380.—Diagram Showing Position of Head in Various Forceps Operations.

ease. I regard this "ironing out" of the vaginal outlet and pelvic floor as so essential that I hold that forceps should not be applied until it has been effected.

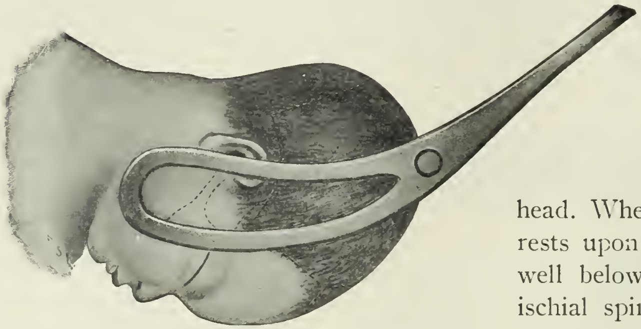

Fig. 381.—Forceps Correctly Applied along Occipitomental Diameter, Pelvic Curve towards Occiput.

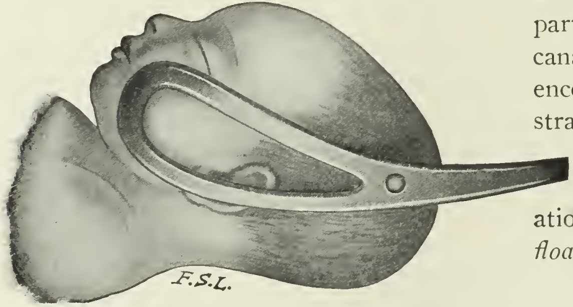

Fig. 382.—Forceps Correctly Applied along Occipitomental Diameter, Pelvic Curve towards Face.

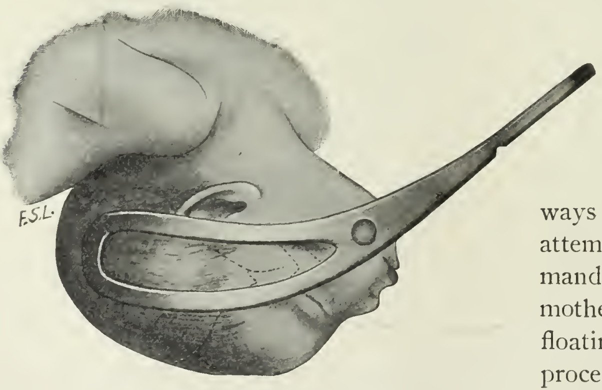

Fig. 383.—Forceps Applied to Face along Occipitomental Diameter.

Application of Forceps.—Forceps operations are designated as low, mid, high, and floating, according to the position of the head. When the presenting part rests upon the perineum, or lies well below the line joining the ischial spines, we speak of *low forceps;* when it presents at or just above the ischial spines, *mid forceps;* when the head has partially descended into the pelvic canal, but its greatest circumference has not passed the superior strait, *high forceps;* and when it is freely movable above the pelvic brim the operation is termed *forceps upon the floating head.*

The low forceps operation usually offers but little difficulty, except in certain funnel-shaped pelves, and may be undertaken upon comparatively slight indications. The mid operation is more difficult, but not often excessively so. On the other hand, the high operation is always difficult, and should not be attempted unless imperatively demanded by the condition of the mother or child. Forceps upon the floating head is a very serious procedure, and is rarely indicated. Generally speaking, the fact that the head is not engaged indicates some disproportion between it and the superior strait, so that the operation should not be thought of until accurate information as to the size of both is available. Moreover, even in those cases in which there is no serious disproportion, delivery can usually be accomplished more safely and rapidly by version

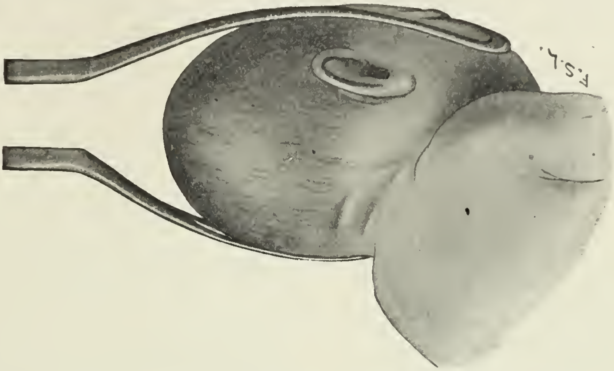

Fig. 384.—Forceps Applied Obliquely over Brow and Mastoid Region.

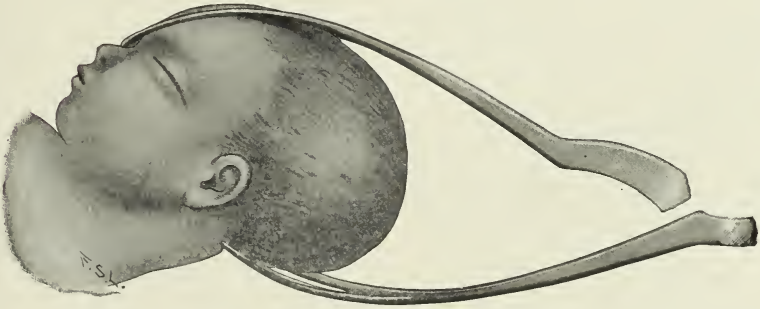

Fig. 385.—Showing that When One Blade Is Applied over Occiput and Other over the Face, Forceps Cannot be Locked.

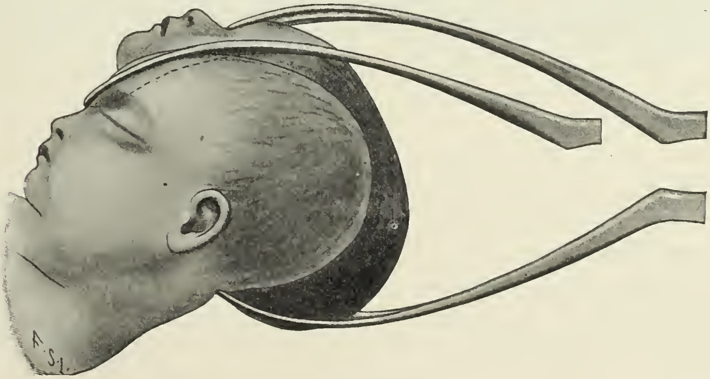

Fig. 386.—Showing Extension of Head When One Blade Is Applied over Brow and Other over Occiput, Explaining Tendency of the Instrument to Slip Off.

The forceps is so constructed that its cephalic curve is best adapted to the sides of the child's head, the biparietal diameter corresponding to the line of greatest distance between the blades. Consequently, the head is grasped in an ideal manner only when the long axis of the blades corresponds to the occipitomental diameter, the fenestra including the parietal bosses and the tips lying over the cheeks, while the concave margins of the blades look toward either the occiput or the face. With such a grasp the forceps obtains a firm hold and cannot slip off, and traction can be made in the most advantageous manner. On the other hand, when the forceps is applied obliquely with one blade over the brow and the other over the opposite mastoid region, the grasp is less secure, and the head is exposed to injurious pressure. If one blade is accurately applied over the face and the other over the occiput, the instrument cannot be locked, while, if the blade over the face is slipped down so as to permit articulation, the grasp is very insecure and each traction tends to extend the head (see Figs. 384 to 386).

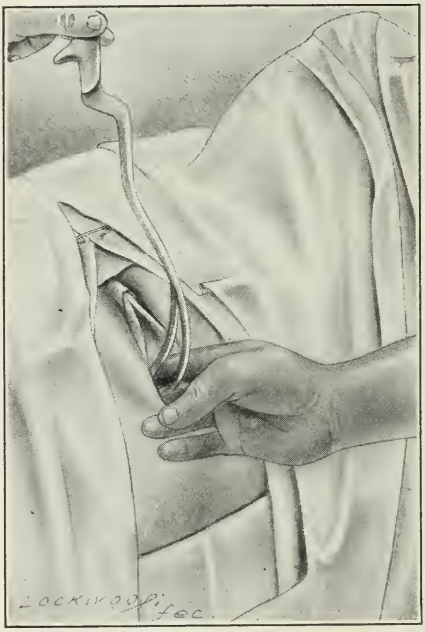

Fig. 387.—Low Forceps; Introduction of Left Blade to Left Side of Pelvis.

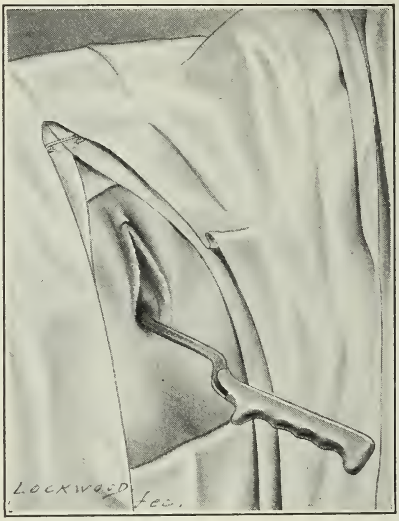

Fig. 388.—Low Forceps; Left Blade in Place.

For these reasons, then, the forceps should be applied, when possible, directly to the sides of the head along its *occipitomental* or *jugoparietal diameter*. This is known as the *cephalic,* in contradistinction to the *pelvic application.* The former was recommended by Smellie and Baudelocque, but, as it is more difficult than the latter, it fell into disuse, and was not generally practiced until Pinard, Farabeuf and Varnier demonstrated the inestimable advantages which it possesses over the pelvic application. In the latter application, the left blade is applied to the left and the right blade to the right side of the mother's pelvis, no matter what the presentation, consequently the head is grasped satisfactorily only when the sagittal suture is directed anteroposteriorly.

An accurate idea of the exact position of the head is essential to the cephalic application. With the head low down, this can usually be obtained by examining with two fingers; but when it is higher up an absolute diagnosis can be made only *by locating the posterior ear,* which necessitates the introduction of the entire hand into the vagina. This, of course, requires profound anesthesia, and is therefore practicable only just before introducing the forceps. After locating the ear, the examining hand remains in place to serve as a guide for the introduction of the first blade, which should be applied over the posterior ear, no matter whether it be the right or left. This rule admits of exception in two instances only—namely, when the head is resting upon the perineum, with the sagittal suture extending anteroposteriorly, or when it is movable at the pelvic brim. In the first case, the head is grasped correctly with either method of application; while in the latter, the application over the ears renders extraction more difficult. It should always be remembered that faulty diagnosis frequently results in an improper application of forceps, and is a leading factor in converting what should be a simple procedure into an operation that is both serious and difficult.

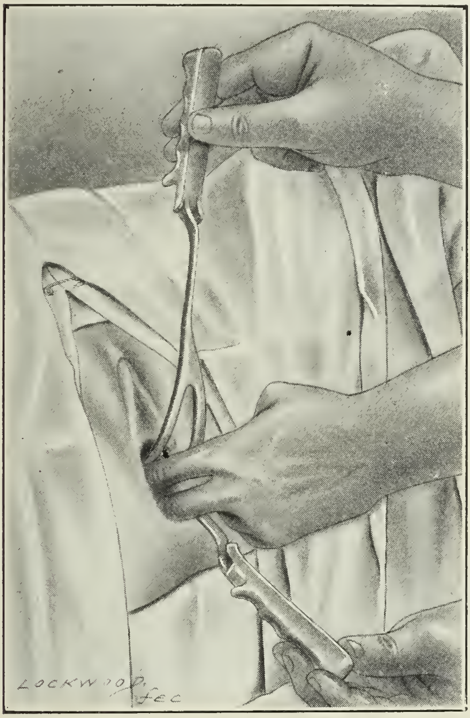

Fig. 389.—Low Forceps; Left Blade in Place, Introduction of Right Blade.

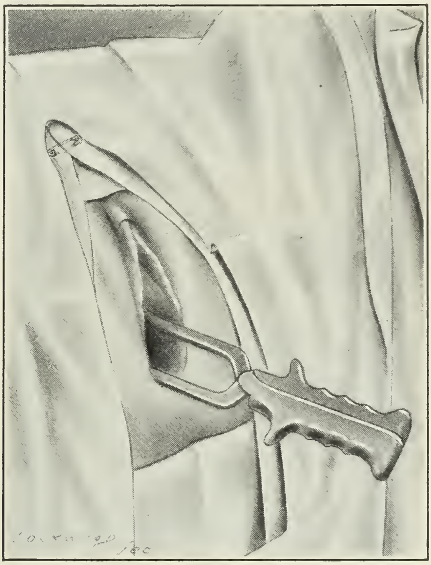

Fig. 390.—Low Forceps; Instrument in Place and Articulated.

Forceps Delivery with the Head at the Vulva.—With the head in this low position, the obstacle to delivery is usually due to insufficient expulsive force or to abnormal resistance on the part of the perineum. In such circumstances the sagittal suture usually occupies the anteroposterior diameter of the pelvic outlet, with the small fontanel directed toward either the symphysis pubis or the concavity of the sacrum. In either event the forceps, if applied to the sides of the pelvis, will grasp the head in an ideal manner. Accordingly, the left blade is introduced to the left and the right blade to the right side of the pelvis, the mode of procedure being somewhat as follows: Two fingers of the right hand are passed into the left and posterior portion of the vulva and carried up the vagina past the margins of the external os. The handle of the left branch is then seized between the thumb and two fingers of the left hand—just as in holding a pen—and the tip of the blade is gently passed into the vagina along the palmar surface of the fingers of the right hand which serve as a guide. As it is introduced, the handle is at first held almost vertically, but, as the blade adapts itself to the head, it is depressed, so that it eventually takes a horizontal position. The guiding fingers are then withdrawn, and the handle is left to itself or is held by an assistant. In the same manner, two

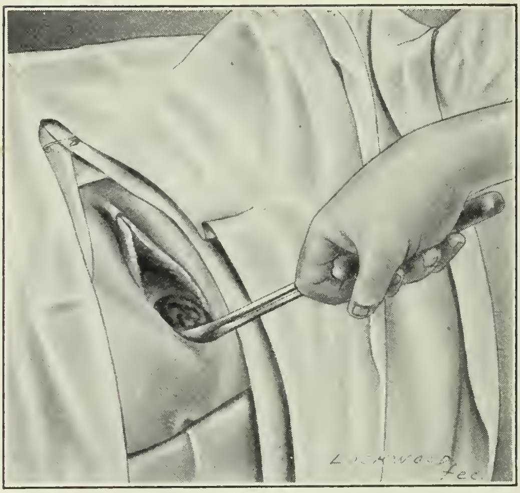

Fig. 391.—Low Forceps; Horizontal Traction.

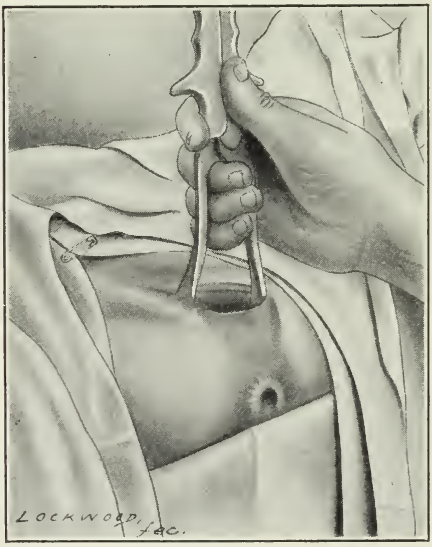

Fig. 392.—Low Forceps; Upward Traction.

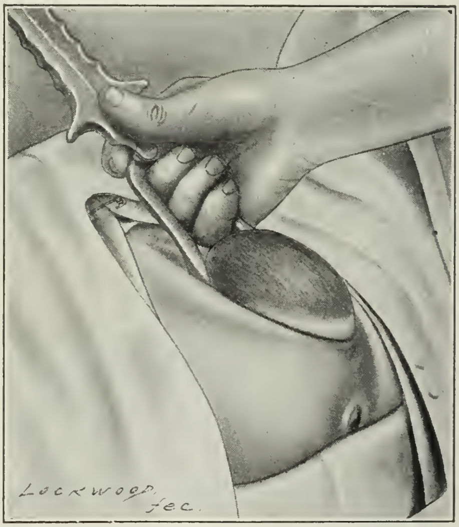

Fig. 393.—Low Forceps; Extreme Upward Traction.

fingers of the left hand are then introduced into the right and posterior portion of the birth canal to serve as a guide for the right blade, which is held in the right hand and introduced into the vagina. The guiding fingers are now removed

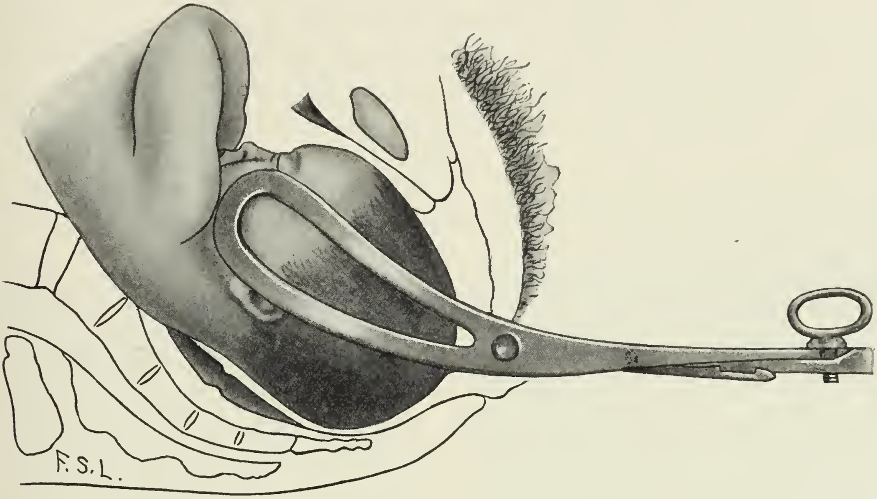

Fig. 394.—Low Forceps; Occiput Directly Posterior; Horizontal Traction (Farabeuf and Varnier).

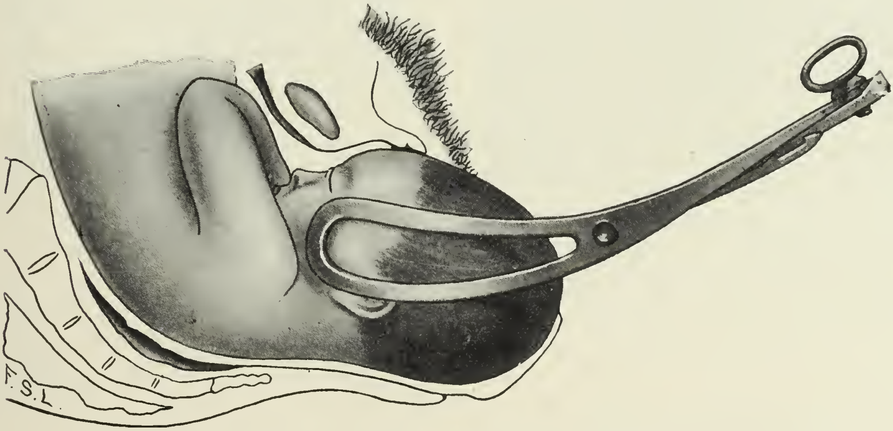

Fig. 395.—Low Forceps; Occiput Directly Posterior; Upward Traction (Farabeuf and Varnier).

and all that remains to be done is to articulate the branches. Usually they lie in such a manner that they can be locked without difficulty; but when this cannot be done, first one and then the other blade should be gently moved until the handles are brought into such a position as to be articulated with ease.

When this has been accomplished, an examination is made to ascertain whether the blades have been correctely applied, or whether they inclose the lips of the cervix. In the latter case the forceps should be loosened and reapplied. When it is certain that the blades are satisfactorily placed, the handles are seized with one hand and gentle intermittent traction is made in a horizontal direction until the perineum begins to bulge. As soon as the vulva begins to be distended by the occiput, the handles are gradually elevated, and eventually come almost in contact with the abdomen of the patient as the parietal bosses emerge. During the latter maneuver, the four fingers should grasp the upper surface of the handles and shanks, while the thumb upon their lower surface exerts the necessary force.

In delivering the head, Nature's method should be simulated as closely as possible, and the minimum amount of force employed. Accordingly, traction should be made intermittently, the head being allowed to recede in the intervals, as in spontaneous labor. Except when urgently indicated, it should be extracted so slowly as to give time for proper stretching and dilatation of the perineum, which in primiparous women cannot be satisfactorily accomplished in less than from ten to fifteen minutes.

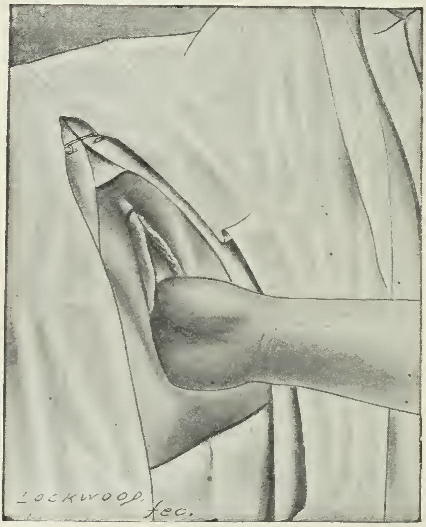

Fig. 396.—Mid Forceps; Hand in Vagina Seeking Posterior Ear.

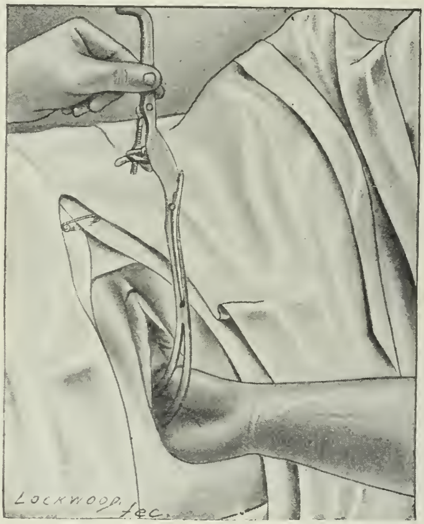

Fig. 397.—Mid Forceps; Introduction of First Blade.

When the vulva is well distended by the head and the brow can be felt through the perineum, the mode of completing delivery varies. I usually do so with the forceps in place, holding that in this way I have the greatest control over the advance of the head. Others, on the contrary, contend that the thickness of the blades adds to the distention of the vulva and thus increases its liability to laceration. For this reason, they remove the forceps and complete delivery by Ritgen's maneuver—slowly expressing the head by making upward pressure upon the brow through the posterior portion of the perineum, the anal region being covered by a towel in order to prevent as far as possible any contamination from the bowel. It is a matter of indifference which procedure is followed, but I prefer the former. Occasionally the forceps are removed too soon, and in this event Ritgen's maneuver proves a tedious and inelegant procedure.

When the occiput lies directly posteriorly, traction should be made in a horizontal direction until the forehead or root of the nose engages under the symphysis, after which the handles should be slowly elevated, until the occiput slowly emerges over the anterior margin of the perineum, and then, by imparting a downward motion to the instrument, the forehead, nose, and chin will successively emerge from the vulva. This extraction is more difficult than when the occiput is anterior, and, owing to the greater distention of the vulva, perineal tears are more liable to occur.

Low and Mid Forceps Operations.—When the head lies above the perineum, the sagittal suture usually occupies an oblique or transverse diameter of the birth canal. In such cases the forceps should always be applied to the sides of the head. This is best accomplished by introducing two or more fingers into the vagina sufficiently deeply to feel the posterior ear, over which, no matter whether it be the right or left, the first blade should be applied.

In left occipito-anterior positions the entire right hand, introduced into the left posterior segment of the pelvis, should locate the posterior ear, and at the same time serve as a guide for the introduction of the left branch of the forceps, which is held in the left hand and applied over the posterior ear. The guide hand is then withdrawn, when the handle may be held by an assistant or left to itself, as the blade will usually retain its position without difficulty.

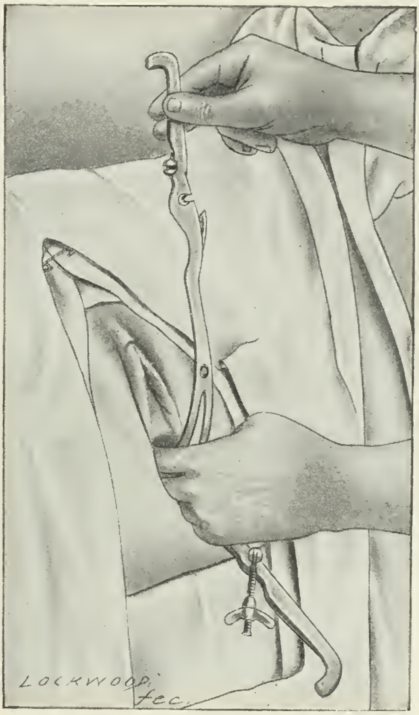

Fig. 398.—Mid Forceps; Introduction of Second Blade.

Two fingers of the left hand are then introduced into the right and posterior segment of the birth canal, no attempt being made to reach the anterior ear, which lies in the neighborhood of the right iliopectineal eminence. The right branch of the forceps, held in the right hand, is then introduced along the left hand as a guide. After its introduction it still remains to apply it over the anterior ear of the child. This is accomplished by gently rotating it anteriorly until it comes to lie directly opposite the blade which was first introduced. The two branches being now articulated, one blade of the forceps occupies the posterior and the other the anterior extremity of the left oblique diameter (see Figs. 399 and 400).

In the right positions, the blades are introduced in a similar manner but in opposite directions, for in this case the right is the posterior ear, over which the first blade inserted must accordingly be placed. It should, however, be remembered that after the blades have been applied to the sides of the head the left handle and shank will lie above the right, and consequently the forceps will not immediately articulate, but this difficulty can be readily overcome by rotating the former around the latter so as to bring the lock into proper position (Fig. 417).

If the occiput is in a transverse position, the forceps is introduced in a similar manner, the first blade being applied over the posterior ear, and the second being rotated anteriorly until it comes to lie opposite the first. In this case one blade lies in front of the sacrum and the other behind the symphysis (Figs. 401 and 402).

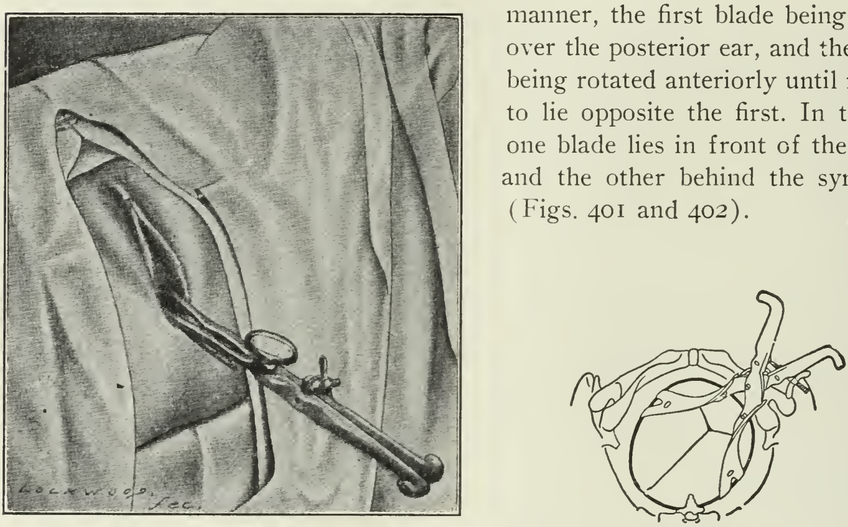

Fig. 399. Fig. 400.

Figs. 399, 400.—Mid Forceps; Instrument Applied in L. O. A.

Whatever the original position of the head may be, delivery is effected by making traction obliquely downward until the occiput appears at the vulva, the rest of the operation being completed in the manner already described. When the occiput is obliquely anterior, it gradually rotates spontaneously to the symphysis pubis as traction is made. But when it is directed transversely, in order to bring it to the front, it is sometimes necessary to impart a rotary motion to the forceps while making traction. The direction in which this is to be made varies, of course, according to the position of the occiput, rotation from the left side toward the middle line being necessary when the occiput is directed toward the left, and in the reverse direction when it is directed toward the right side of the pelvis (see Figs. 401, 403).

In making traction, before the head appears at the vulva, one or both hands may be employed according to the amount of force required. When the Simpson forceps are used, one hand grasps the handles of the instrument, while the fingers of the other are hooked over the transverse projection at their upper ends. Care must be taken not to employ too much force. To avoid this error the operator should stand or sit with his arms flexed and the elbows held closely against the thorax, as it is not permissible to make use of the body weight, and still less to brace the feet against the side of the bed (Fig. 404).

Application of Forceps in Obliquely Posterior Positions.—Prompt delivery may become necessary when the small fontanel is directed toward one or other sacro-iliac synchondrosis—namely, in R. O. P. and L. O. P. presentation. When interference is required in either of these, the head usually lies at or below the level of the ischial spines, and is often imperfectly flexed.

In many cases, when the hand is introduced to locate the posterior ear, the occiput will rotate spontaneously to a transverse position, and delivery by forceps is then accomplished, as already described. If, however, rotation does not occur, the head should be seized, with four fingers over its posterior and the thumb over its anterior ear, and an attempt made to rotate the occiput to a transverse position. This can usually be accomplished with ease, and occasionally even rotation to an anterior position can be brought about. The forceps is then applied as described above. In other cases, after manual rotation has been effected, the head slips back into its original position before the forceps can be applied. To obviate this difficulty, DeLee recommends seizing the scalp by means of a pair of bullet forceps and holding the head in the desired position until the blades are adjusted.

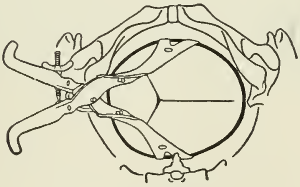

Fig. 401.

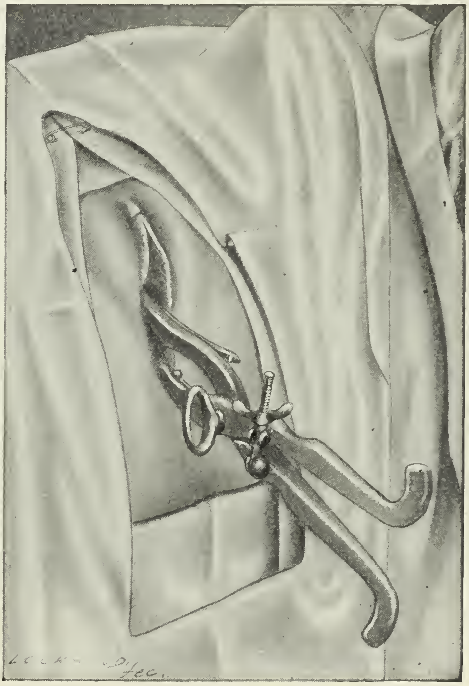

Fig. 402.

Figs. 401, 402.—Mid Forceps; Instrument Applied in R. O. T.

In a small proportion of cases, however, manual rotation cannot be effected, and in them the forceps must be applied with the occiput still directed obliquely posterior. In these circumstances, if the instrument be applied to the sides of the head, or even obliquely, and it is attempted to effect delivery by making traction in the usual manner, great difficulty is experienced and powerful traction usually fails to bring about the desired result. It is this experience which has given rise to the great dread in which these presentations are generally held, and it is a very good practical rule, whenever unexpected difficulty is experienced in delivering what is apparently a simple anterior presentation, to think of the possibility of a mistake in diagnosis and to reëxamine the patient. It will then generally be found that a mistake has been made, and that the small fontanel lies in the neighborhood of one or other sacro-iliac synchondrosis.

In order to effect delivery, the head must be rotated so as to bring its sagittal suture into coincidence with the anteroposterior diameter of the pelvic outlet. This can be accomplished by rotating the occiput by means of the forceps, either through an arc of 45 degrees to the hollow of the sacrum, or through one of 135 degrees to the symphysis pubis (Figs. 405 and 406). The latter is more advantageous, for the reason that delivery in the directly posterior position is more difficult and also more likely to give rise to deep perineal tears.

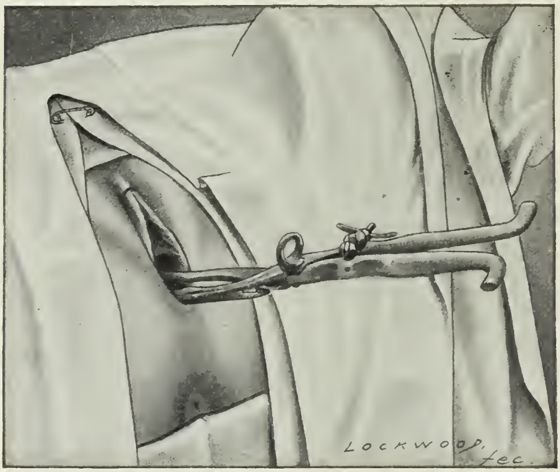

Fig. 403.—Mid Forceps; Rotation to R. O. A.

Unfortunately, when it is desired to rotate the occiput forward, the forceps, if applied to the sides of the head with the pelvic curvature directed upward, becomes inverted by the time rotation is completed, so that the pelvic curve then looks posteriorly, and an attempted delivery with the instrument in this position is liable to cause serious injury to the maternal soft parts (Figs. 407 and 408). In order to avoid this, it is best to remove and reapply the instrument, as described below. If one wishes to avoid this double application, the head may be seized obliquely with one blade over the anterior brow and the other over the posterior mastoid region; but this is not advisable, however, as the procedure is more difficult for the operator and far more dangerous for the child.

The *double application of forceps,* which was described in the explanations accompanying Plate XXI of Smellie's tables, and rediscovered by Scanzoni nearly a century later, has given such excellent results in my hands that I employ it to the exclusion of all other methods whenever the occiput cannot be rotated manually from its obliquely posterior position. It, however, is rarely necessary, and in my service is employed in only a small percentage of all obliquely posterior occipital presentations. As the right posterior variety is much the more frequent, I shall describe the steps of the operation in some detail.

In the first application the blades are applied to the sides of the head with the pelvic curve looking toward the face of the child, whereas in the second manipulation it looks toward the occiput. For the first application (Figs. 409 and 410) the right hand is passed into the left posterior segment of the genital tract, and the posterior (right) ear sought for. Over it the left blade is applied. This is held in position by an assistant, while the operator's left hand is passed

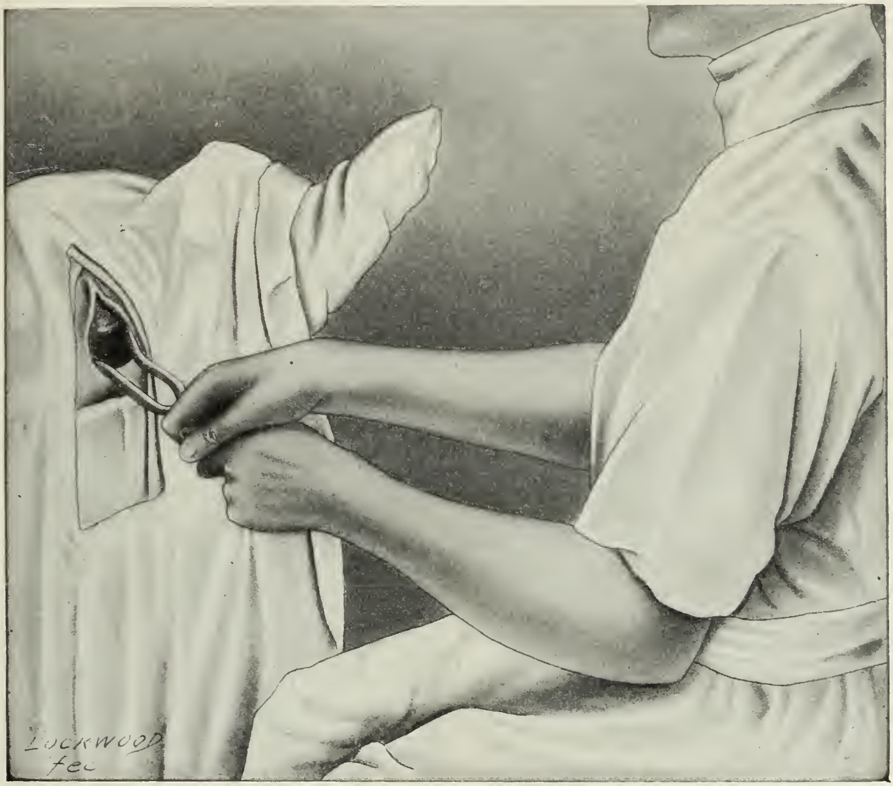

Fig. 404.—Showing Manner of Making Traction in Mid Forceps Operation.

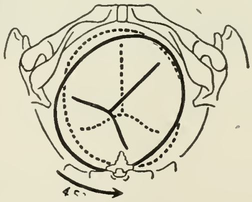

Fig. 405.

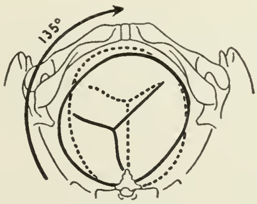

Fig. 406.

Figs. 405, 406.—Diagrams Showing Rotation of Obliquely Posterior Occiput to Sacrum and Symphysis Pubis, Respectively.

into the right side of the vagina controlling the introduction of the right blade, which is then rotated anteriorly until it comes to lie opposite the blade first introduced. The forceps is then locked, its blades now occupying the left and the sagittal suture the right oblique diameter of the pelvis. Downward traction is then made, and at the same time a rotary motion is imparted to the forceps when the head slowly descends and rotates to a right transverse, and later on when it impinges upon the pelvic floor to an obliquely anterior position (see Figs. 411 and 412).

The forceps having become inverted, must be taken off, and reapplied in the usual manner to the head, which now occupies a right anterior position, when delivery is readily accomplished. Some difficulty may arise in bringing about proper articulation, since the handle of the left branch lying above the right cannot be locked, but this can be readily overcome by rotating the former around the latter so as to bring the lock into proper position (see Fig. 417). In left positions the blades are applied in a similar manner, but in the reverse direction.

By this method I have been able to deliver many women with ease after the usual methods had failed. Indeed, my experience has been so satisfactory that I have ceased to dread occipitoposterior presentations, and now regard them with equanimity, feeling that delivery can be readily and safely effected when necessary. Bill, of Cleveland, is an enthusiastic advocate of a similar procedure, except that he rotates the head before beginning to make traction.

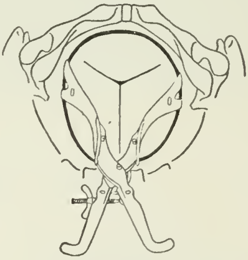

Fig. 407.

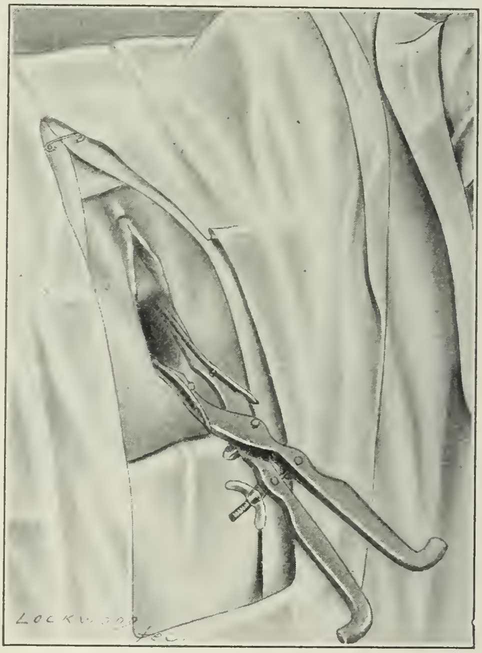

Fig. 408.

Figs. 407, 408.—Showing Inversion of Forceps when Anterior Rotation from an R. O. P. Position is Completed.

To avoid the necessity of constantly bearing in mind which is the left and which the right branch of the forceps, it is a good practical rule for a beginner, after having made an accurate diagnosis of the position of the head, to articulate the forceps and to hold them before the vulva of the patient. In this way he readily appreciates how they should be applied, and which blade is to go over the posterior ear.

Kielland, of Christiania, in 1916, described a forceps with narrow, somewhat bayonet-shaped blades, which he claims can readily be applied to the sides of the head, and surpasses all other models as a rotator. He introduces the anterior blade first with its cephalic curvature directed forward, and, after it has entered sufficiently far into the uterine cavity, he turns it through 180 degrees in order to adapt the cephalic curvature to the head. He holds that it is particularly useful in the high application, but in my experience it possesses no advantages over the Tarnier forceps. Many German writers are very enthusiastic concerning it, but I am inclined to believe that their enthusiasm is in great part due to the fact that its use has compelled them to utilize the cephalic application, which I learned years ago in France. Neumann, in 1926, gave his experience with the Kielland forceps in 132 deliveries and speaks highly of it.

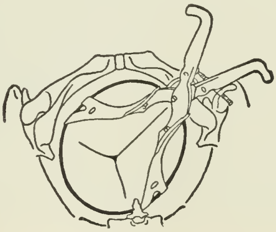

Fig. 409.

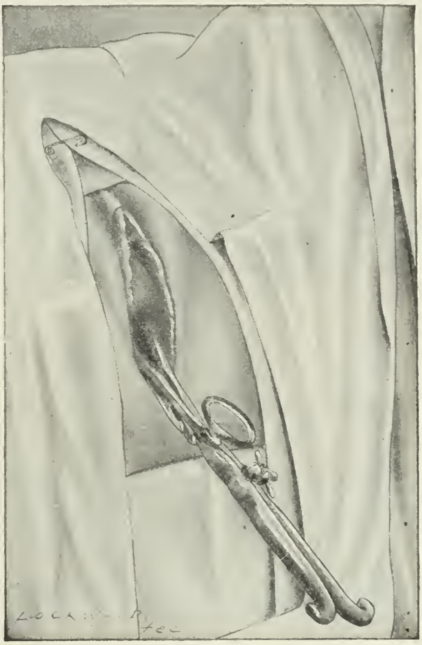

Fig. 410.

Figs. 409, 410.—Scanzoni's Maneuver; First Application of Forceps.

Figure 419 illustrates a new type of forceps described by Barton, and well spoken of by Caldwell, Studdiford, and Bachman. It differs from all other types in that the anterior blade is hinged where it joins the shank. It appears to be particularly useful when the sagittal suture occupies the transverse diameter of the pelvic canal, but I cannot speak of its advantages from personal experience.

High Forceps.—As has already been said, the high are much more difficult than the mid or low forceps operations, and should not be undertaken unless urgent indications are present. If the head be well engaged, the forceps should be applied as in the mid or low operation, except that, owing to the more elevated position of the head, the blades must be introduced for a greater distance into the genital tract before being applied.

On the other hand, if the entire head lies above the superior strait, or only a small segment of it is engaged, the use of forceps is usually contra-indicated, as failure of engagement generally indicates the existence of disproportion between the head and the pelvis. If, however, the operation appears to be called for, and the sagittal sutures lies transversely, as it usually does if the pelvis is contracted, the forceps should be applied obliquely, one blade over the mastoid and the other over the opposite brow. To my mind this is the only condition in which the interests of the mother and child are not best served by the cephalic application; but in these circumstances, the blades of the forceps, if applied to the sides of the head, will occupy the extremities of the conjugata vera, and still further increase the disproportion. More important still is the fact that the posterior blade bridges over the anterior concavity of the sacrum and thus prevents the head from entering the pelvic cavity, thereby defeating the very purpose for which the operation would be undertaken (Fig. 420).

Axis-traction Forceps.—With the ordinary long forceps, the high and occasionally even the mid operation is comparatively difficult, strong traction being necessary to effect delivery. This is due to the fact that, owing to the shape of the birth canal and of the forceps, it is impossible to exert traction directly in the axis of the superior strait. The latter, as we know, would, if continued downward, pass through the lower portion of the sacrum; but, owing to the presence of the perineum, the extremity of the sacrum and the coccyx, it is impossible to depress the handles of the forceps sufficiently to permit of traction in the desired direction. As a consequence, a very considerable part of the force exerted is wasted in dragging the head against the symphysis, instead of bringing it downward. Thus, Tarnier pointed out that a force of 40 pounds employed in a high forceps operation would be resolved into two forces—one of 30 pounds and the other of 26 pounds—the former being in the axis of the superior strait and serving to bring about descent, whereas the latter would be

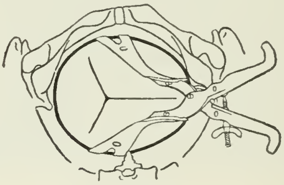

Fig. 411.

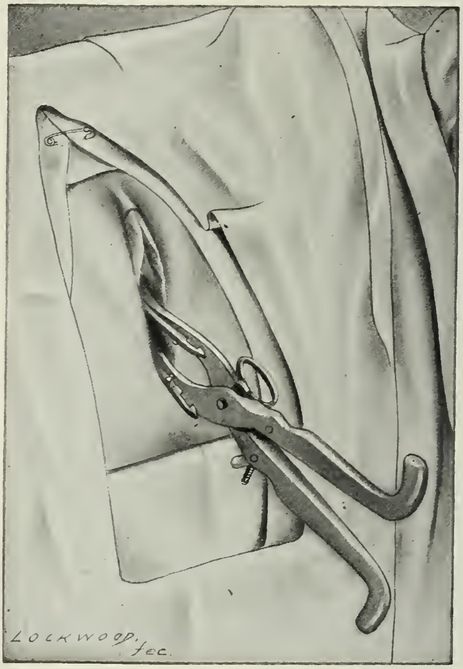

Fig. 412.

Figs. 411, 412.—Scanzoni's Maneuver; Showing Rotation to Transverse Position.

directed against the symphysis pubis and would not only be wasted, but would actually retard delivery (Fig. 421).

This defect in the forceps has long been recognized. Saxtorph, in 1772, suggested that delivery could be greatly facilitated by attaching a lac to the eye of each blade and making traction upon these, as well as with the handles. He also showed that a similar result might be attained by making strong downward pressure with one hand in the neighborhood of the lock, while the other was used for traction. This maneuver is variously attributed to Osiander and Pajot, but was recommended by Saxtorph forty-four years before either was born (Fig. 422).

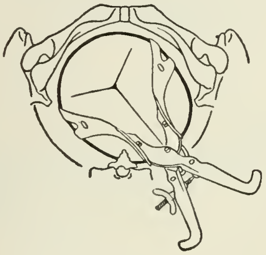

Fig. 413.

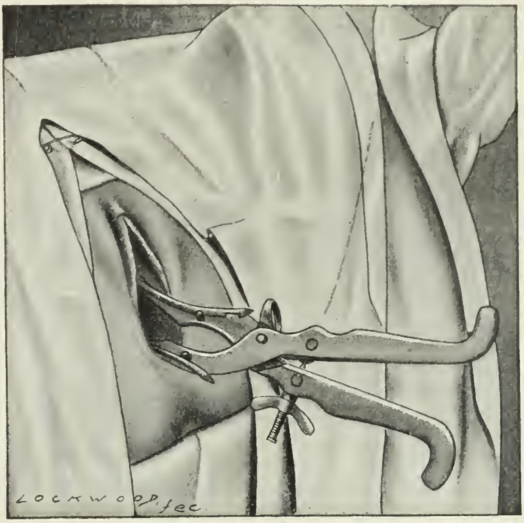

Fig. 414.

Figs. 413, 414.—Scanzoni's Maneuver; Showing Rotation to Anterior Position, Forceps Now Inverted.

Hermann, of Berne, in 1844, was the first to attempt to overcome the difficulty by devising an axis-traction forceps, his crude instrument being shown in Figure 423. Hubert, of Louvain (1860), found that in certain cases, by turning the handles down-

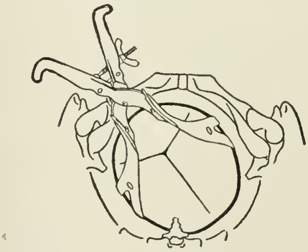

Fig. 415.

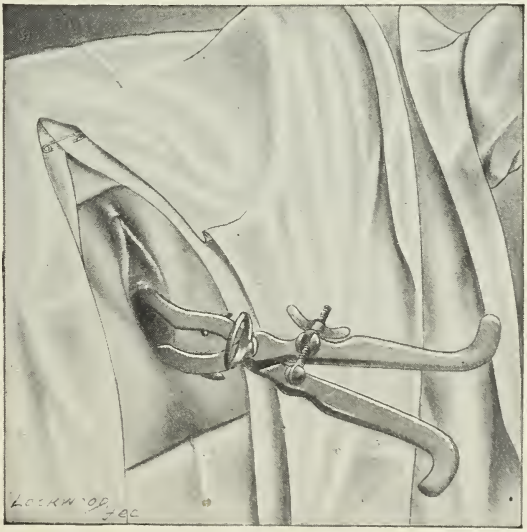

Fig. 416.

Figs. 415, 416.—Scanzoni's Maneuver; Second Application of Forceps.

ward, he could make traction along the axis of the superior strait, his instrument giving ideal results when the sagittal suture was directed anteroposteriorly, but being useless in all other positions. Moralès (1871) added a perineal curve to the forceps, but his invention possessed the same disadvantages as that of Hubert. None of these instruments were of much practical value, but they served to emphasize the faults of those in general use.

Finally, in 1877, Tarnier solved the problem by attaching a rod to each blade and connecting them with a traction bar. His original forceps possessed a definite perineal curve, and was very cumbersome. The importance of his invention was soon recognized, and obstetricians throughout the world promptly attempted to improve upon it; so that at present one or more modifications of axis-traction forceps, each designated by the name of the modifier, are to be found in every large city. The modification devised by Milne Murray enjoys great popularity in Great Britain, but to my mind it is inferior to the last Tarnier model.

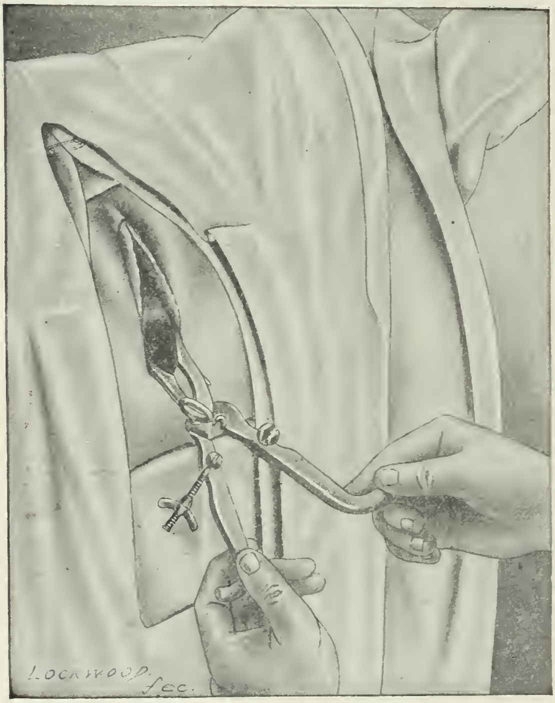

Fig. 417.—Scanzoni's Maneuver; Showing Difficulty in Articulating Blades in Second Application of Forceps.

Tarnier himself, not considering his original forceps satisfactory, continued to make changes and improvements, so that before his death he had devised an instrument which leaves little to be desired. It is practically a long French forceps without a perineal curve, provided with short, detachable traction rods, one of which is inserted just beyond the eye of each blade. When not in use, these are held in place by a pin upon the under surface of the shank, from which they can be readily freed, and attached by their free ends to a traction attachment which terminates in a handle bar which can be grasped by one or both hands (see Figs. 427 and 428).

With this device, traction can be made almost in the axis of the superior strait, and, owing to the presence of numerous joints in the traction attachment, the instrument can be used in any position. The handles of the forceps merely serve to indicate the direction in which traction should be made, the force being applied to the handle bar, which is held horizontally no matter what the position of the blades may be, the traction rods being kept about one centimeter beneath the handles (Fig. 429).

To my mind, this instrument is superior to all other axis-traction forceps, and with it excellent results can be obtained with a minimum expenditure of energy, and by its aid a delivery can occasionally be effected which would have been impossible with the ordinary instruments. One of its best points is the joint between the horizontal and vertical portions of the traction attachment, as a result of which the handle bar can be held horizontally, even though the forceps is applied at the ends of the anteroposterior diameter of the pelvis. I use this instrument in all cases, without the traction rods in low, and with them in mid and high forceps operations.

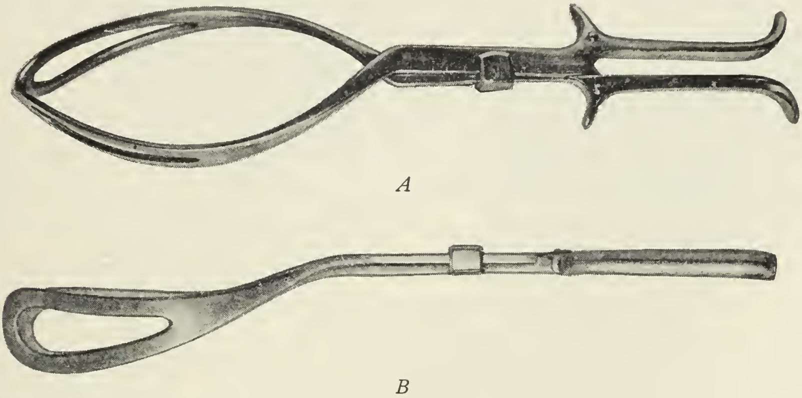

Fig. 418.—Kielland's Forceps.
A, front view; *B,* side view. × ¼.

Application of Forceps in Face Presentations.—In face presentations the application of forceps occasionally becomes necessary, but is usually successful only in the transverse and anterior varieties, the blades being applied to the sides of the head along the mento-occipital diameter, with the pelvic curvature directed toward the neck. Traction is made in a downward direction until the chin appears under the symphysis; then by an upward movement the face is slowly extracted through the vulva, the nose, eyes, brow, and occiput appearing in succession over the anterior margin of the perineum.

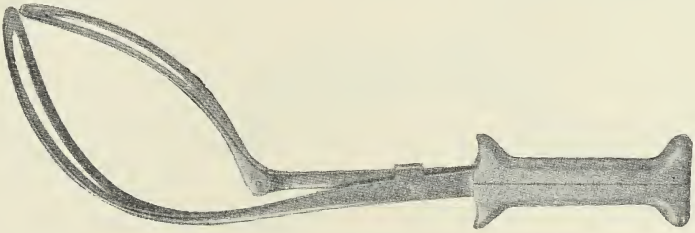

Fig. 419.—Barton's Forceps. × ¼.

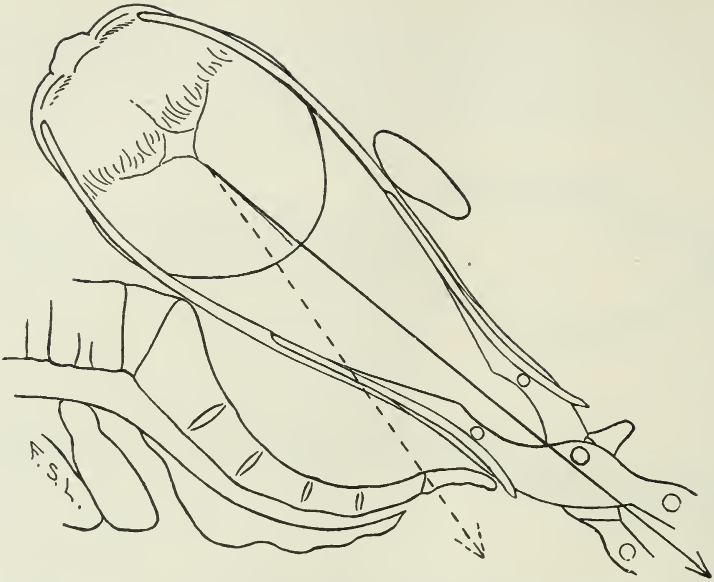

FIG. 420.—DIAGRAM SHOWING DEFECT OF CEPHALIC APPLICATION OF FORCEPS WHEN HEAD IS AT SUPERIOR STRAIT; BLACK LINE INDICATING DIRECTION OF ACTUAL AND BROKEN LINE THAT OF IDEAL TRACTION (Farabeuf and Varnier).

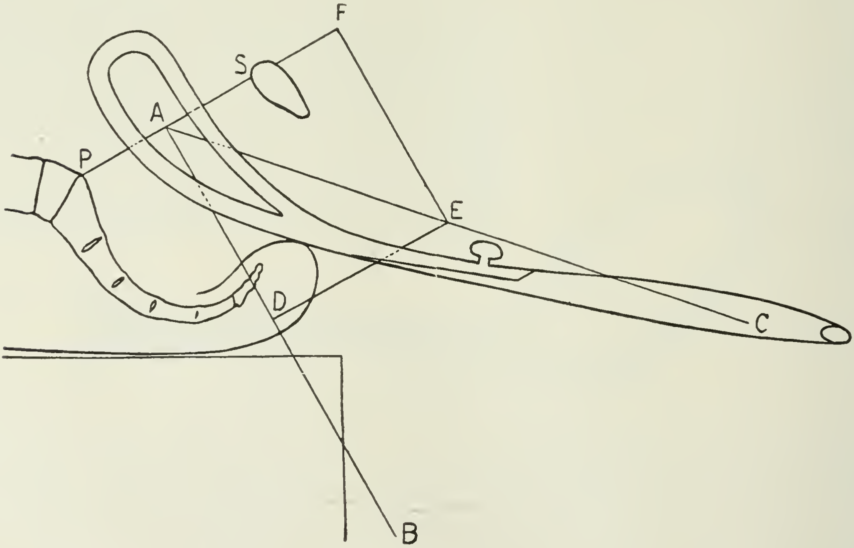

FIG. 421.—TARNIER'S DIAGRAM; SHOWING DEFECTS OF ORDINARY FORCEPS. *A E C,* line of actual traction; *A D B,* line of desired traction; *A S F,* force wasted against symphysis pubis.

Forceps should not be applied when the chin is directed toward the hollow of the sacrum, as delivery cannot be effected in that position. In exceptional cases, if version is out of the question, and conversion into a vertex presentation cannot be effected, an expert operator may endeavor to rotate the chin to a transverse and later to an anterior position before resorting to pubiotomy or craniotomy, though such attempts are rarely successful.

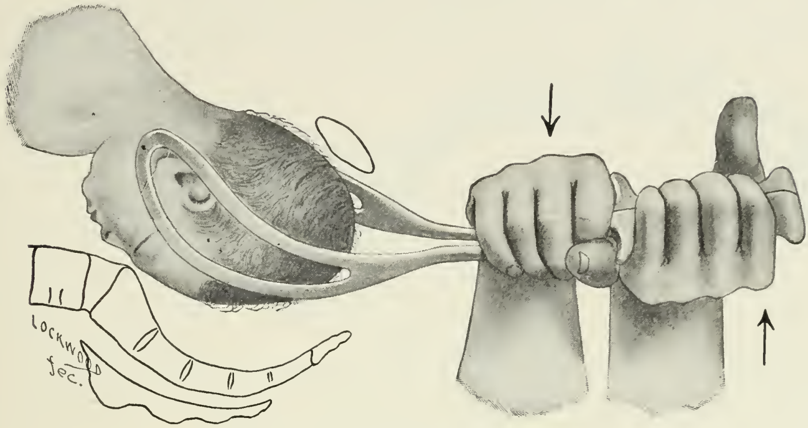

FIG. 422.—SAXTORPH MANEUVER.

Application of Forceps in Breech Presentations.—Occasionally the application of forceps is recommended in frank breech presentations, the blades being applied over the trochanters. In such circumstances, the blades usually slip off, as their cephalic curvatures make the grasp uncertain. Consequently, delivery can usually be effected more satisfactorily by the methods to be mentioned in the following chapter.

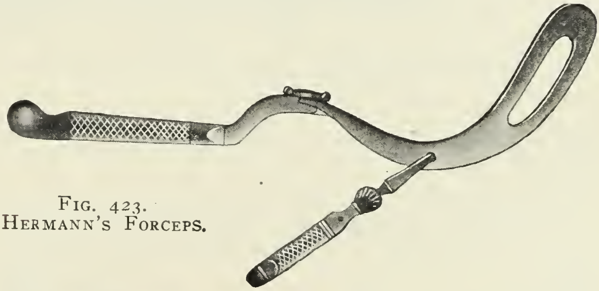

FIG. 423.
HERMANN'S FORCEPS.

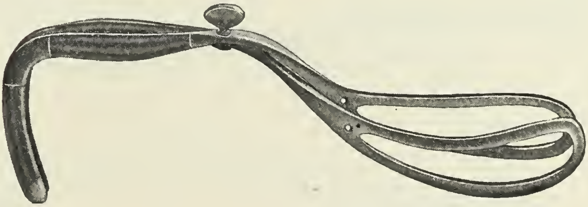

FIG. 424.—HUBERT'S FORCEPS.

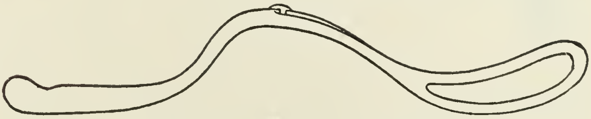

FIG. 425.—MORALÈS' FORCEPS.

From the time of Smellie, many authors have recommended the extraction of the *after-coming head* in breech presentations by means of the forceps. In such cases the body of the child is carried up over the abdomen of the mother, and the blades are introduced under it and applied to the sides of the head.

Figure 430 illustrates a special type of forceps, which Piper has devised for this purpose, and which is longer than the usual instrument and possesses a perineal curve. He claims that it greatly diminishes the danger of injury to the child, and prefers it to Mauriceau's method of extraction, which will be described in the following chapter. My experience with it has been too slight to permit a positive expression of opinion, but I feel that it will scarcely replace the Mauriceau maneuver, as the more expert one becomes in the use of the latter, the less frequently will difficulty be experienced in delivering the after-coming head.

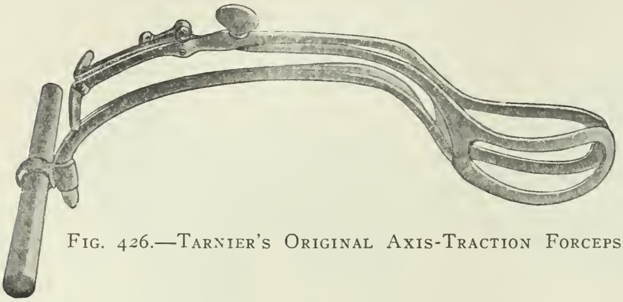

Fig. 426.—Tarnier's Original Axis-Traction Forceps.

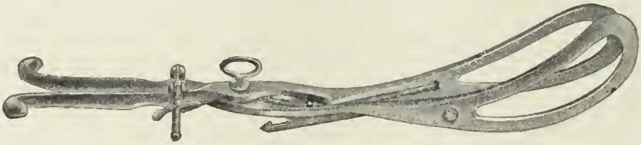

Fig. 427.—Tarnier's Forceps; Traction Rods in Place without Handle Bar.

Prognosis.—Low and mid forceps operations, when intelligently performed upon healthy women under proper aseptic precautions, should not be followed by maternal mortality, the operation being undertaken to save maternal or fœtal life.

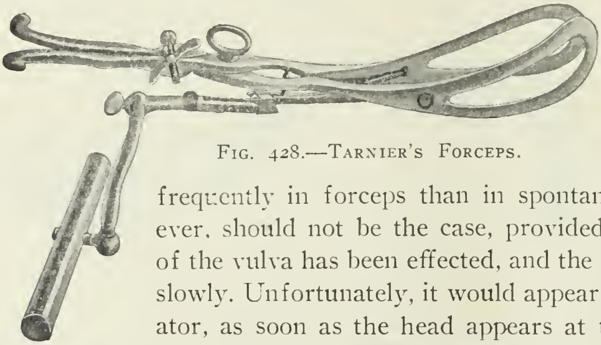

Fig. 428.—Tarnier's Forceps.

It is generally held that perineal tears occur more frequently in forceps than in spontaneous deliveries. This, however, should not be the case, provided that preliminary dilatation of the vulva has been effected, and the head is extracted sufficiently slowly. Unfortunately, it would appear as though the average operator, as soon as the head appears at the vulva, is seized with an almost uncontrollable desire to effect its immediate delivery by brusque traction, instead of imitating nature and devoting some time to overcoming the resistance of the perineum and vulval outlet. Leopold has stated that the forceps is the bloodiest of all obstetrical operations, and this is undoubtedly true if the child is rapidly dragged through a partially dilated birth canal by brute force. On the other hand, if properly employed, it is a means of sparing instead of destroying the perineum, inasmuch as the exit of the head can be controlled quite as effectively by means of the forceps as by any other procedure.

Attempts at delivery through an imperfectly dilated cervix are most dangerous, and frequently give rise to deep cervical tears, which may lead to the death of the patient from hemorrhage or infection. Moreover, the application of forceps requires an accurate diagnosis as to the position and presentation of the child, and when this is lacking, and the forceps is incorrectly applied in certain occipitoposterior or brow presentations, delivery can be effected only by brute force, which can hardly fail to cause serious lesions for mother and child. Similar untoward results often follow an attempt to drag the head forcibly through a markedly contracted superior strait or pelvic outlet.

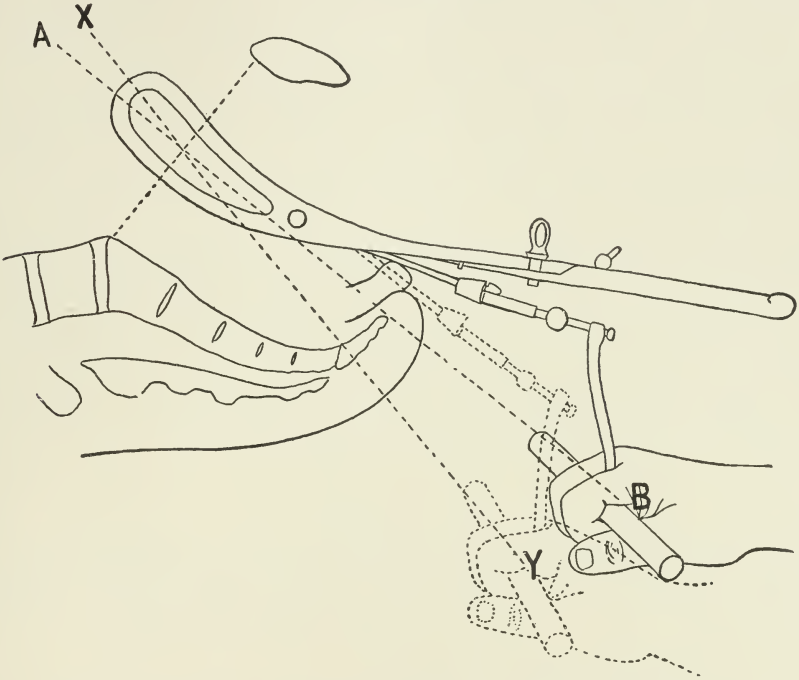

FIG. 429.—DIAGRAM SHOWING TRACTION WITH TARNIER'S FORCEPS. *A B* in proper and *X Y* in improper manner (Ribemont-Dessaignes).

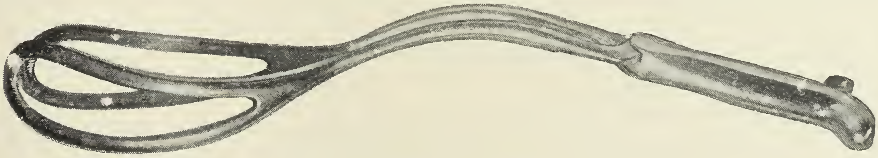

FIG. 430.—PIPER'S FORCEPS. × ¼.

The fœtal mortality depends upon the condition of the child at the time the operation is undertaken, as well as upon the position of the head. It should be practically zero in low and mid operations, except when a funnel-shaped pelvis has been overlooked. In a comparatively large experience, I can recall very few children whose deaths could be directly attributed to such operations when properly performed. On the other hand, the high forceps operation is attended by a serious fœtal mortality, which becomes still greater when the head is not engaged. In such cases the head may be subjected to injurious pressure, which may lead to intracranial hemorrhage and the subsequent death of the child. In rare instances actual fracture of the skull may occur, and occasionally the upper part of the occipital bone may become separated from its base.

Occasionally the child may be born with *facial paralysis,* or the condition may develop shortly after birth. This is usually noted when the head has been seized obliquely, and is due to the pressure exerted by the posterior blade of the forceps upon the neighborhood of the stylomastoid foramen, through which the nerve leaves the skull. Not every facial paralysis, however, following delivery by forceps, should be attributed to the operation, as such a condition is occasionally encountered after a spontaneous labor, and may be due to intracranial causes quite independent of the use of instruments. Full literature upon this subject up to 1901 will be found in Macé's article.

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CHAPTER XXI

EXTRACTION AND VERSION

EXTRACTION

Extraction in Breech Presentations.—The delivery of the child by traction when the feet protrude from the vulva in breech presentations was probably the earliest obstetrical operation.

From the time of Hippocrates up to the beginning of the sixteenth century, head presentations alone were considered normal, and hence all the authorities, with the exception of Celsus, advised the conversion of breech into vertex presentations at any cost, even though it rendered necessary amputation of the limbs. After the resuscitation of podalic version by Ambroise Paré and Jacques Guillemeau, more rational views prevailed, so that in the seventeenth century we find Mauriceau advising the method of extraction which is in general use at the present time.

As the technic of the operation varies according as one has to deal with a complete breech or a foot, or with a frank breech presentation, it will be necessary to consider the two conditions separately. In both the essential prerequisite for the successful performance of extraction lies in the complete dilatation of the cervix and the absence of any serious mechanical obstacle. It is true that extraction through an imperfectly dilated cervix is sometimes possible, but this is usually effected only at the cost of deep cervical tears with resulting hemorrhage. Moreover, the additional resistance offered to the passage of the head will generally lead to its extension, the arms at the same time becoming elevated over it, thereby so complicating and delaying delivery that the child is almost invariably lost. For these reasons, when extraction is indicated in the interests of the mother, it should always be preceded by complete manual dilatation of the cervix.

Indications for Extraction.—It has already been pointed out that the fœtal mortality is considerably greater in breech than in vertex presentations, since in the former death from asphyxiation is almost inevitable if the mouth of the child be not brought to the vulva within eight minutes after the appearance of the umbilicus. Complete delivery of the head is not essential as all that is necessary, in case of delay, is to have the mouth in such a position as to permit the access of air without danger of aspiration of the vaginal contents. The untoward result may be due to one of several causes. Thus, the cord may be subjected to such pressure between the pelvic brim and the head, as to check completely the circulation. Less frequently the rapid decrease in the size of the uterus, following the extrusion of the body of the child, results in premature separation of the placenta.

Consequently, in all breech presentations, preparations should be made for extraction as soon as the feet or buttocks appear at the vulva, so that the operation can be promptly resorted to if, after the appearance of the umbilicus, the extrusion of the rest of the body does not promptly follow. In a certain number of cases, no matter what the location of the breech, extraction may be called for by some condition which threatens the life of the mother or child, just as in vertex presentations. It should, however, be realized that the passage of meconium is without significance, as it is simply the result of the compression to which the abdomen of the child is being subjected. Moreover, it should be remembered that extraction by the feet constitutes the usual method of completing delivery following internal podalic version. Consequently, as that operation has a wide field of usefulness, extraction is employed in association with it more frequently than for primary breech presentations—in which event the joint procedure is designated as version and extraction.

Extraction by the Feet.—Before beginning the operation, the patient should be placed upon a suitable operating table, but if one is not available she should be brought to the edge of the bed and subjected to the usual preliminary preparations. Complete anesthesia is desirable, even when the body of the child has already been born and only the head remains to be extracted.

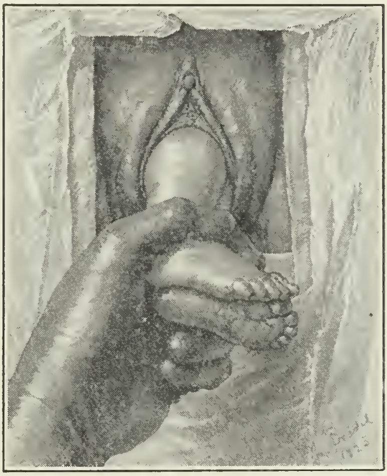

Fig. 431.—Breech Extraction; Traction upon the Feet.

As a rule, extraction is a simple operation when the breech has been born spontaneously; whereas it is less so when the feet are still within the uterus. In the latter case, after "ironing out" the vaginal opening and pelvic floor, the entire hand should be introduced into the vagina and both feet seized, the ankles being grasped in such a manner that the second finger lies between them. The feet are then brought down into the vagina, and traction is made until they appear at the vulva. If, however, difficulty is experienced in seizing both feet, one should be brought down, and the hand immediately reintroduced in order to grasp and extract the other.

As soon as the feet have been drawn through the vulva, they should be wrapped in a sterile towel so that a firmer grasp may be obtained, since the vernix caseosa renders them so slippery that they are difficult to hold. Traction is then made in a downward direction (Fig. 431), and as the legs emerge they are grasped higher up, first by the calves and later by the thighs. When the breech appears at the vulva, traction is made in an upward direction until it is delivered. The thumbs are then applied over the sacrum and the fingers over the hips, and traction is continued in the same manner until the costal margins, and later the scapulæ, become visible (Figs. 432 to 434). As the buttocks emerge the back of the child looks more or less upward, but as further traction is made it tends to turn spontaneously toward the side of the mother toward which it was originally directed. If, however, this does not occur, a slight rotary movement should be added to the traction with the object of bringing the bisacromial diameter of the child in approximation with the anteroposterior diameter of the outlet.

As soon as the operator begins to pull upon the thighs, an assistant should exert pressure upon the uterus in the axis of the superior strait, with the object of preserving the flexed attitude of the head and preventing the arms from becoming extended above it. If, however, there is no disproportion and the cervix is fully dilated, this precaution is in great part unnecessary. Besides serving these purposes, it also aids directly in the expulsion of the child.

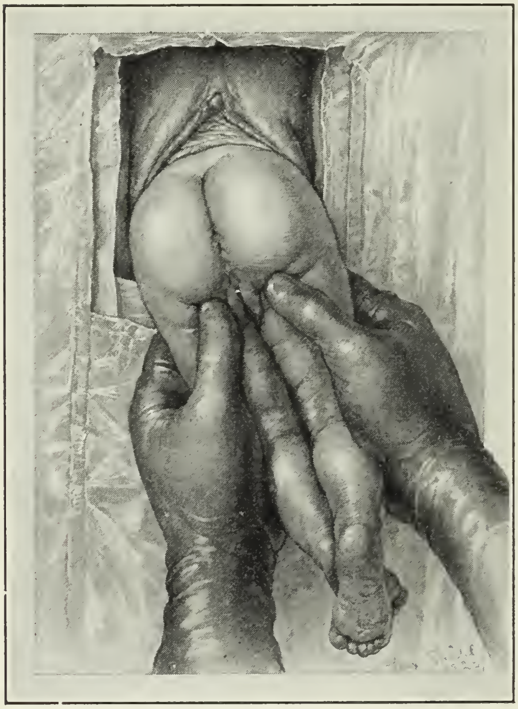

Fig. 432.—Breech Extraction; Traction upon the Thighs.

In my experience, the cardinal point in successful extraction is to continue downward traction until at least the lower halves of the scapulæ are outside of the vulva, and to give no thought to the birth of the shoulders and arms until one of the axillæ becomes visible. Failure to observe this rule frequently renders difficult what would otherwise be a simple procedure. As soon as one axilla becomes visible, the time has arrived for the delivery of the shoulders, and, so long as the arms maintain their normal flexed attitude, it makes little difference which shoulder is delivered first; as it sometimes happens, when it is planned to deliver one, that the other is born spontaneously.

As the result of early training, I usually deliver the posterior shoulder first, while Potter prefers the anterior one. To deliver the former, the feet are grasped in one hand and drawn upward over the groin of the mother corresponding to the ventral surface of the child; in this way leverage is exerted upon the posterior shoulder, which slips out over the perineal margin and is usually followed by the arm and hand (Fig. 435 A). Then by depressing the body of the child the anterior shoulder emerges beneath the pubic arch, the arm and hand usually following it spontaneously (Fig. 436). When this has occurred, the back tends to rotate spontaneously in such a way that it becomes directed more or less upward, or, in case it fails to do so, it is brought about by rotating the body manually, and then all is ready for the delivery of the head.

Unfortunately, however, the process is not always so simple and it sometimes becomes necessary to free and deliver the arms. This is much less frequently called for than in the past, and I attribute the change to following the admonition to continue traction without thought of the shoulders until an axilla becomes visible, instead of proceeding to free the arms shortly after the costal margins emerge.

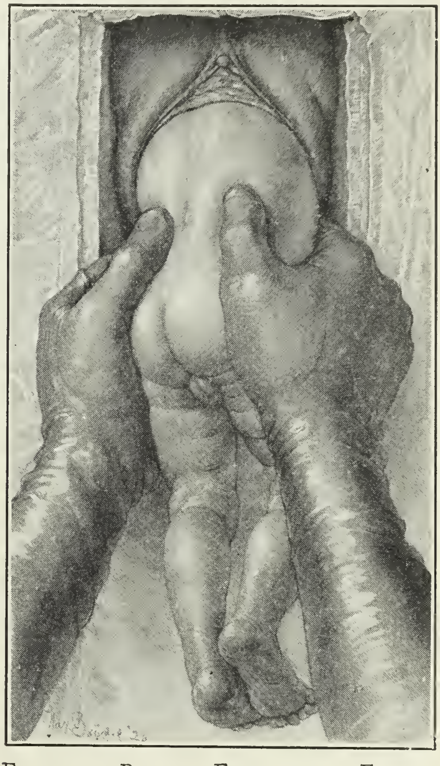

Fig. 433.—Breech Extraction; Extraction of Body, Thumbs over Sacrum.

Since there is more available space in the posterior and lateral segments of the pelvis than elsewhere, the posterior arm should be freed first. As the corresponding axilla is already visible, upward traction upon the feet is continued and two fingers of the other hand are passed along the humerus until the elbow is reached (Fig. 435 B). The fingers are now applied in such a way as to serve as a splint to the arm, which is swept downward over the thorax and delivered from the vulva. To effect the delivery of the anterior arm, it is sometimes only necessary to depress the body of the child, when it slips out spontaneously; in other cases it can be wiped down over the thorax using two fingers as a splint, while occasionally the body must be seized with the thumbs over the scapulæ and rotated so as to bring the undelivered shoulder into the neighborhood of the nearest sacrosciatic notch. The legs are then carried upward, so as to bring the ventral surface of the child to the opposite groin of the mother, after which the arm can be delivered as described above.

If the arms have become extended over the head their delivery, although more difficult, can usually be accomplished by the maneuvers just described. In doing this, particular care must be taken to carry the fingers up to the elbow and to use them as a splint, for, if they are merely hooked over the arm, the humerus or clavicle is exposed to great danger of fracture.

Very exceptionally the arm is found around the back of the neck, when its delivery becomes still more difficult. If it cannot be freed in the manner just described, its extraction may be facilitated by rotating the child through half a circle in such a direction that the friction exerted by the birth canal will serve to draw the elbow toward the face; but if this fails, the arm must be forcibly extracted by hooking a finger over it. In this event, fracture of the humerus or clavicle is, unfortunately, very common. Such an accident, however, is not very serious, as good union can always be secured by appropriate treatment.

After the shoulders have been born, the head usually occupies an oblique diameter of the pelvis with the chin directed posteriorly, when its extraction is best effected by *Mauriceau's maneuver* (Fig. 437). For this purpose, the index finger of one hand is introduced into the mouth of the child and applied over the superior maxilla, while the body rests upon the palm of the hand and the forearm, with the legs straddling the latter. Two fingers of the other hand are then hooked over the neck, and, grasping the shoulders, make downward traction until the occiput appears under the symphysis. The body of the child is now raised up toward the mother's abdomen, and the mouth, nose, brow, and eventually the occiput successively emerge over the perineum. Traction should be exerted only by the fingers over the shoulders, and not by the finger in the mouth; since the latter may slip from the superior maxilla and come to rest upon the inferior maxilla and base of the tongue, as a consequence of which serious injury may be done to the child.

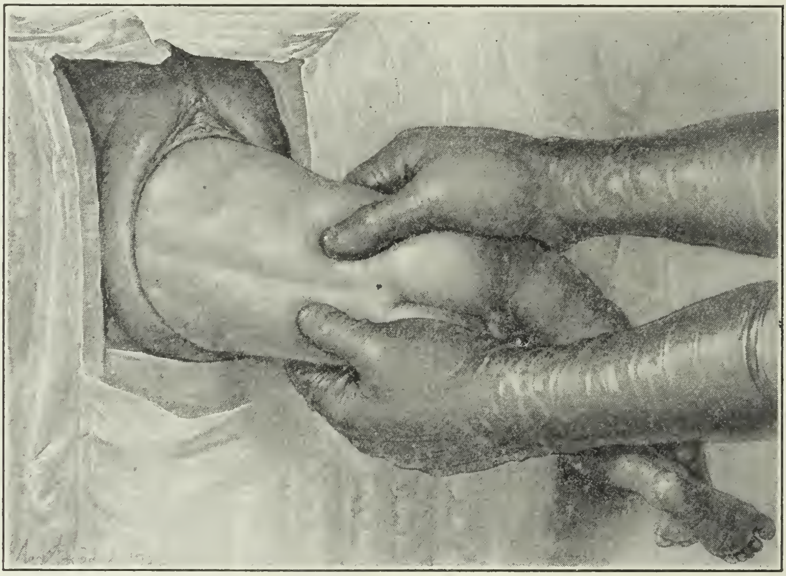

FIG. 434.—BREECH EXTRACTION; SCAPULAE VISIBLE.

This maneuver was first practiced by Mauriceau in the seventeenth century, but for some reason fell into disfavor. Nearly a hundred years later Smellie described a similar procedure, but rarely made use of it, as he preferred the employment of forceps. In the meantime other devices came into use until G. Veit, in 1863, redirected attention to the inestimable advantages which Mauriceau's method of extraction possessed over all others. For this reason in Germany the procedure is frequently called after Veit, or, when greater accuracy is desired, it is designated as the Mauriceau-Smellie-Veit maneuver. Litzmann, however, correctly pointed out the impropriety of such a designation, and insisted that only the name of the original inventor—Mauriceau—should be used in describing it. Numerous other methods of extraction have been devised, Winckel, in 1888, being able to collect twenty-one different proced-

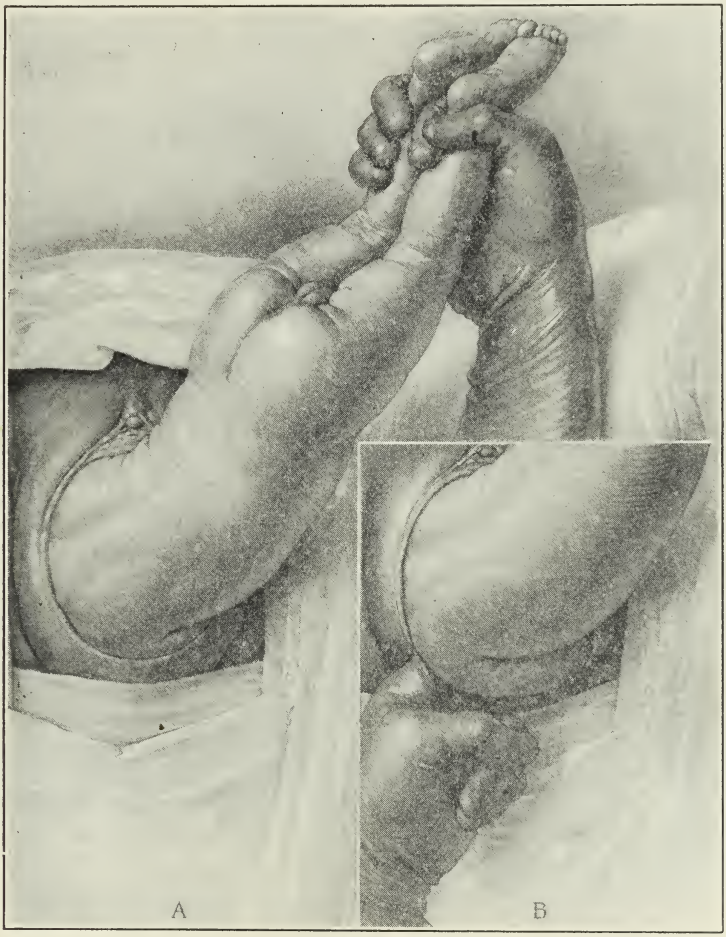

Fig. 435.—Breech Extraction; *A*, Upward Traction to Effect Delivery of Posterior Shoulders; *B*, Freeing Posterior Arm.

ures from the literature, although none has proved as serviceable as that of Mauriceau.

In the vast majority of cases the back of the child eventually rotates toward the front, no matter what its original position; but when it does not take place spontaneously the movement may be inaugurated by making stronger traction upon the leg, which would naturally rotate anteriorly. If this does not bring about the desired result, and the back remains posterior after the birth of the shoulders, extraction must be begun with the occiput posterior. As a rule, rotation can still be effected by means of the finger in the mouth, after which the head can be extracted by Mauriceau's maneuver. When, however, this is not possible, delivery must be attempted, with the head in its abnormal position, by the employment of a modified *Prague maneuver,* which is so called for the reason that its advantages were strongly urged more particularly by Kiwisch of that city, although it had been described by Pugh a century earlier. The procedure is somewhat as follows: Two fingers of one hand grasp the shoulders from below, while the other hand draws the feet up over the abdomen of the mother. As a result the occiput is born first and the perineum is necessarily subjected to greater liability of rupture.

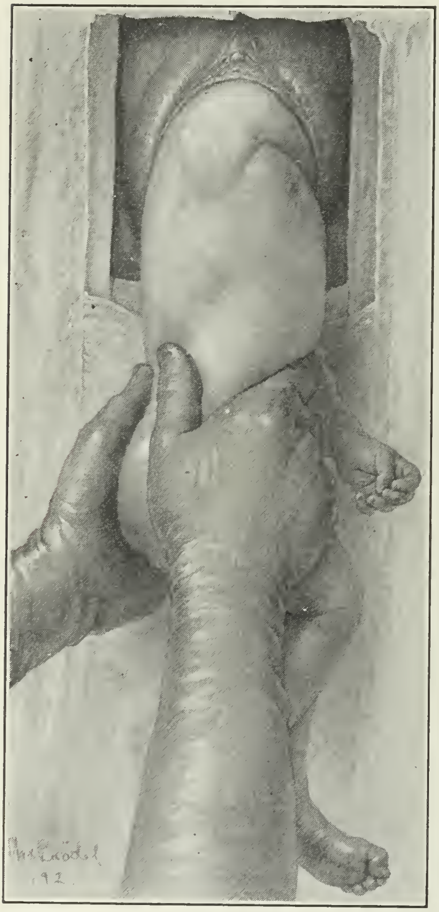

Fig. 436.—Breech Extraction; Delivery of Anterior Shoulder by Downward Traction.

Extraction of Frank Breech Presentations.—When indications for delivery arise after the frank breech has descended deeply into the birth canal its extraction can usually be effected without difficulty by hooking the index finger of one hand into the anterior groin and making traction until the buttocks appear at the vulva, the index finger of the other hand being then inserted into the posterior groin in order to furnish additional aid.

On the other hand, when the breech is high up, delivery is much more difficult. In such cases it is advisable to try to decompose the wedge and to bring down one or both feet, which can be readily accomplished if the membranes have only recently ruptured, but becomes extremely difficult if a considerable time has elapsed after the escape of the liquor amnii, more particularly if the uterus has become tightly contracted over the child.

In many cases the employment of the following maneuver suggested by Pinard will aid materially in bringing down the foot: Two fingers are carried up along one leg to the knee and push it away from the middle line. This is usually followed by spontaneous flexion, and the foot of the child will be felt to impinge upon the back of the hand, when it can be readily seized and brought down (Fig. 441).

In view of the fact that it is often very difficult to seize and bring down a foot late in the second stage of labor, Ahlfeld and others have suggested the propriety of rupturing the membranes as soon as the cervix is fully dilated, and bringing down a foot prophylactically, so that a convenient tractor may be available in case extraction becomes necessary. This can be readily accomplished but is not advisable as a routine practice, since the frank breech forms a much better dilating wedge than the incomplete breech presentation. The procedure is justifiable, however, when it appears probable that extraction may eventually be required, as in elderly primiparæ, or in patients suffering from heart lesions.

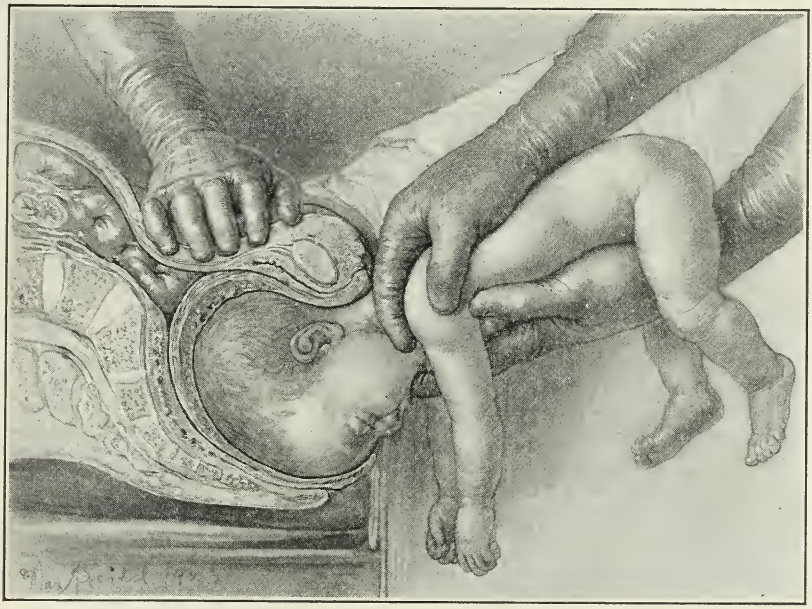

Fig. 437.—Breech Extraction; Mauriceau's Maneuver, Upward Traction.

If the indication for delivery is urgent, and it is impossible to bring down a foot, the child must be extracted as it lies. For this purpose the index finger of one hand is hooked into the anterior groin, and strong downward traction made, supplemented, if necessary, by the use of the other hand, which grasps the wrist.

This procedure is continued until the posterior buttock has reached the pelvic floor, when the index finger of the other hand is hooked into the posterior groin and traction then made with both hands. As soon as this becomes possible, delivery can usually be readily effected, but unfortunately, in a considerable number of cases, it is extremely difficult to bring the breech low enough to secure this advantage. For this reason, when the frank breech is high up, its extraction should not be attempted unless imperatively demanded by the condition of the mother or child.

As soon as the buttocks are born, first one leg and then the other is drawn out and extraction is accomplished as described above. As was said before, traction should be supplemented by pressure upon the abdomen from above. This precautionary measure should never be neglected, as delivery can frequently be accomplished by its aid when it would be impossible if traction by the fingers were alone relied upon. Indeed, it is not until one has attempted a difficult frank breech extraction that one learns how little force can be exerted by the fingers.

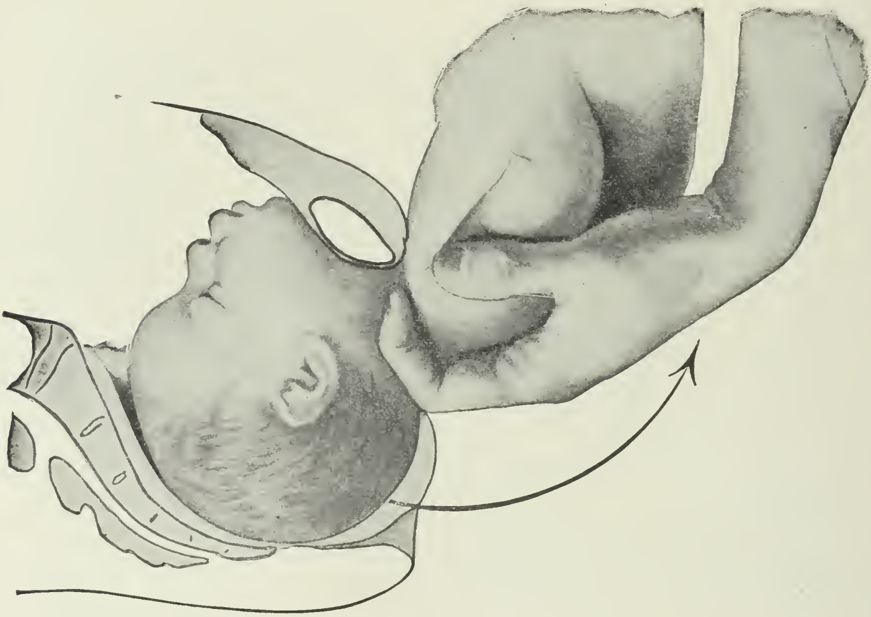

Fig. 438.—Delivery of After-coming Head, Reversed Prague Maneuver.

Use of Forceps.—In view of the difficulty which sometimes attends the extraction of the frank breech when high up, various authorities have recommended the employment of forceps, the blades being applied obliquely, one over the sacrum and the other over the thighs. As was pointed out in the preceding chapter, the cephalic curvature of the ordinary forceps necessarily renders the

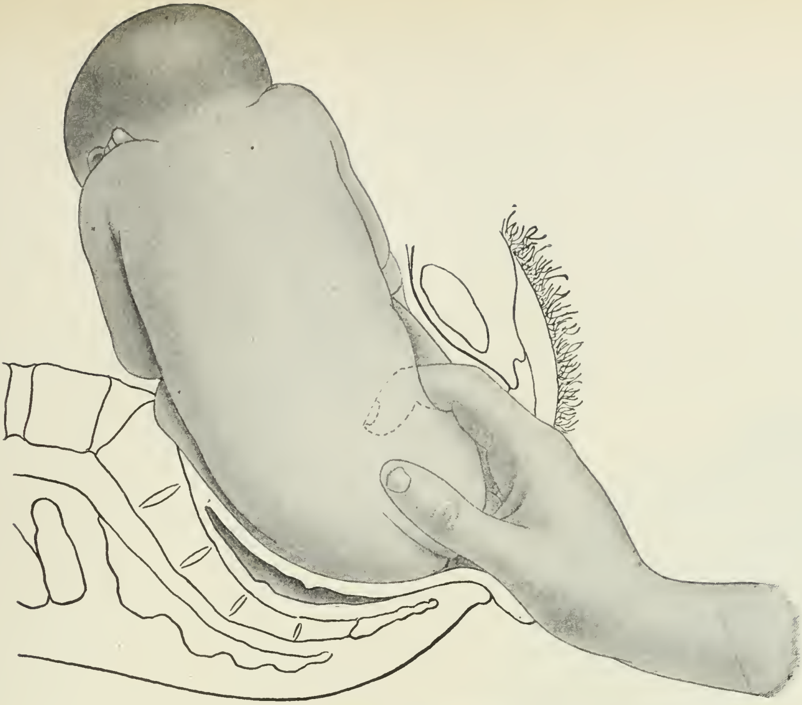

FIG. 439.—EXTRACTION OF FRANK BREECH; FINGER IN ANTERIOR GROIN.

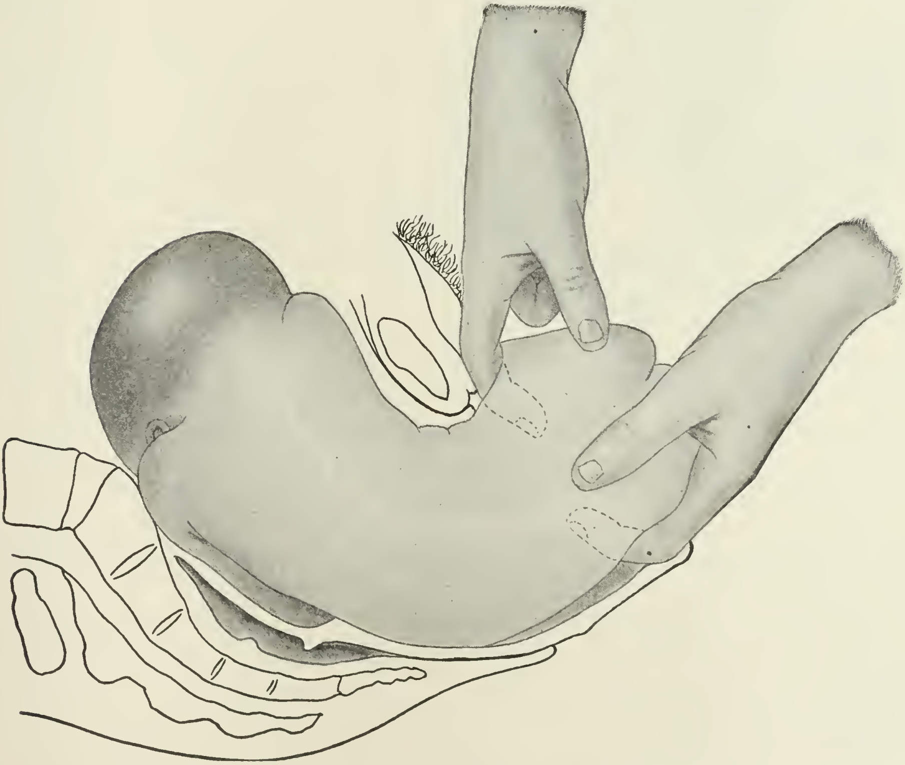

FIG. 440.—EXTRACTION OF FRANK BREECH; FINGERS IN GROINS.

grasp insecure, and to obviate this difficulty Framm has devised a specially constructed instrument. I have had no experience with it, as I have never found it necessary to apply forceps to the frank breech. When, however, traction exerted with a finger in the groin fails, the application of forceps may be indicated, but it should be regarded as a confession of failure and should be deferred until the necessity for intervention becomes imperative.

In all forms of breech presentation, the application of forceps to the aftercoming head has been advocated. It was first practiced by Smellie, and reference has already been made to the instrument especially devised by Piper for the purpose. In general, it may be said that forceps is rarely utilized by those who have become adept in the use of Mauriceau maneuver, but when they are used, the body of the child is elevated toward the abdomen of the mother and the blades applied under it to the sides of the head.

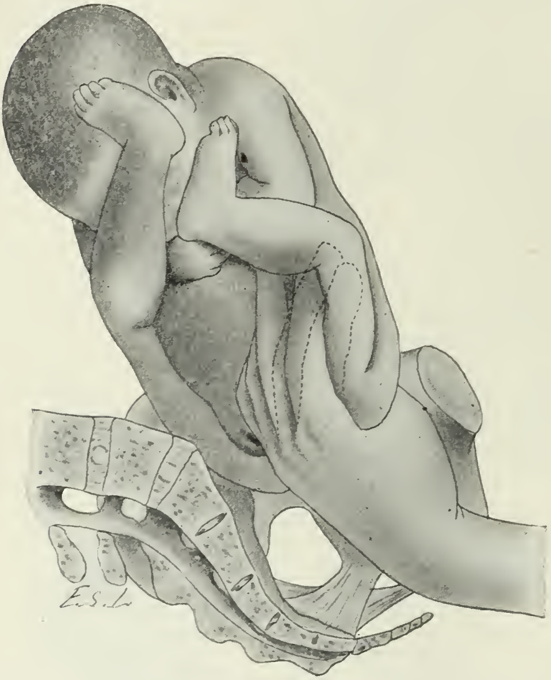

Fig. 441.—Pinard's Maneuver for Bringing Down a Foot in Frank Breech Presentation.

The Fillet.—In frank breech extractions, it is sometimes convenient to make use of the fillet. This may consist of several thicknesses of sterile gauze bandage which are passed over the anterior groin. The fillet is a very efficient tractor, but its application offers considerable difficulty. Unless the operator has at his disposal a specially constructed instrument, a fairly satisfactory carrier may be improvised from a rubber catheter, through which a piece of stout thread is passed, a loop being allowed to protrude from the eye. A stylet is then introduced and, an appropriate curve having been given to the catheter the bent extremity is passed around the anterior groin until the fingers in the vagina can seize the loop, to which one end of the fillet is attached, after which the latter is cautiously drawn up into place.

Aside from the difficulty encountered in applying it, the disadvantage of the fillet is its liability to cut through the skin of the groin; but this can be avoided by employing several thicknesses of gauze and taking care that they do not become twisted into a cord.

The older authors advocated making traction upon the groin by means of a metallic hook. This instrument should never be employed upon living children on account of its liability to cause fracture of the femur. On the other hand, when the child is dead, and such an accident is a matter of indifference, the hook affords a convenient means of making traction.

In all forms of breech extraction the prognosis for the mother is good, although it is more serious in frank breech than in the other varieties. In the former the increased manipulation affords greater opportunity for infection; while the attempt to reach the posterior groin often gives rise to deep, and sometimes to complete, tears before the buttocks have reached the perineum. In extraction by the feet, on the other hand, provided the outlet has been "ironed out" as a preliminary procedure, the liability to perineal tears is no greater, and is possibly less, than in head presentations. Moderate degrees of disproportion between the size of the head and the pelvis scarcely influence the maternal prognosis, since the pressure of the head upon the soft parts lasts but a few seconds, instead of being prolonged for hours as in head presentations.

For the child, however, the outlook is not so favorable, and becomes more serious the higher the presenting part is situated at the beginning of the operation. In addition to the increased liability to tentorial tears and intracerebral hemorrhage, which Eardley Holland, Capon, and Crothers have shown are inherent to breech presentations, the fœtal mortality is augmented by the greater probability of the occurrence of traumatism during extraction.

As has already been said, factures of the humerus and clavicle cannot always be avoided when freeing the arms, while fracture of the femur may occur in difficult frank breech extractions. Occasionally, hematomata of the sternocleidomastoid muscles develop after the operation, though they usually disappear spontaneously. More serious results, however, may follow separation of the epiphyses of the scapula, humerus or femur. Exceptionally, paralysis of the arm follows pressure upon the brachial plexus by the fingers in making traction, but more frequently it is due to overstretching the neck while freeing the arms. When the child is forcibly extracted through a contracted pelvis, spoon-shaped depressions or actual fractures of the skull may result, which generally prove fatal, while occasionally even the neck may be broken when great force is employed. In general it may be said that in simple extractions the prognosis for the child is good, while in complicated ones it is dubious.

VERSION

Version, or turning, is an operation through which the presentation of the fœtus is artificially altered, one pole being substituted for the other, or an oblique or transverse being converted into a longitudinal presentation.

According as the head or breech is made the presenting part, the operation is spoken of as cephalic or podalic version, respectively. It is also designated according to the method by which it is accomplished. Thus we speak of *external version* when the manipulations are made exclusively through the external abdominal wall; of *internal version* when the entire hand is introduced into the uterine cavity; and of *combined version* when one hand manipulates through the abdominal wall, while two or more fingers of the other are introduced through the cervix.

Cephalic Version.—This operation was practiced from the most remote antiquity, and only gradually fell into disfavor after the introduction of podalic version by Paré and his followers. After the discovery of Wigand (1807) that the position of the child could easily be altered by manipulations through the abdominal walls, external cephalic version came into more general use, and since the publications of Hubert and Pinard has become a well-recognized procedure in certain conditions.

The object of the operation is to substitute a vertex for a less favorable presentation. As it does not, however, afford a means for immediate delivery, its field of usefulness is comparatively limited, and its employment is still further restricted by various contra-indications.

Indications.—If a breech or transverse presentation is diagnosed in the last weeks of pregnancy, its conversion into a vertex should be attempted by external maneuvers, provided there be no marked disproportion between the size of the child and the pelvis. Cephalic version is indicated by reason of the increased fœtal mortality attending spontaneous delivery in breech presentations; while if the child lies transversely a change of presentation is imperatively demanded, inasmuch as a natural labor is out of the question, and if appropriate measures are not adopted the lives of both mother and child will be lost.

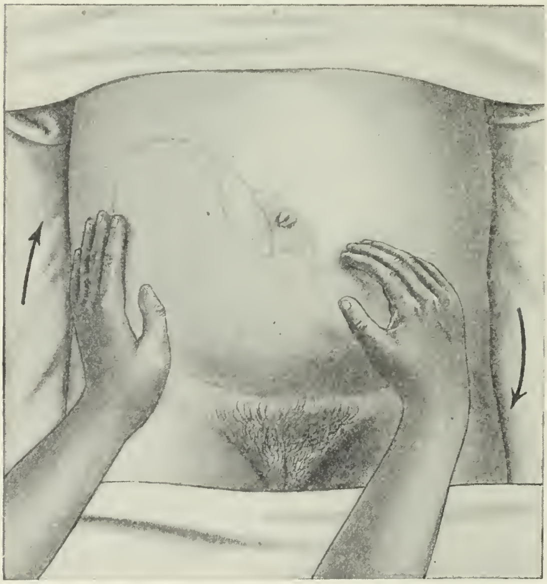
Fig. 442.—External Cephalic Version (Pinard).

External cephalic version can be accomplished only under the following conditions: (1) The presenting part must not be deeply engaged; (2) the abdominal wall must be sufficiently thin to admit of accurate palpation; (3) the abdominal and uterine walls must not be too irritable; (4) the uterus must contain a sufficient quantity of liquor amnii to permit the easy movement of the child. Given these essentials, it should always be attempted. I have employed it with great satisfaction in hundreds of patients and in no way share the apprehension of many writers that it may give rise to twisting or to loops of the cord about the fœtus or even lead to premature separation of the placenta. To my mind, its only drawback consists in the fact, that after the accomplishment of external version, the child tends to return to its original position, unless the head promptly becomes engaged. Many authorities claim that this can be prevented by holding the child in place by an especially contrived abdominal bandage, but in my experience such devices are useless.

In the early stages of labor, before the membranes have ruptured, the same indications hold good, and at this time may be extended to oblique presentations as well, though these usually right themselves spontaneously as labor progresses. On the other hand, external cephalic version can be effected but rarely after the cervix has become fully dilated and the membranes have ruptured. Serious pelvic contraction is a decided contra-indication, since, although external version may be readily accomplished, the procedure is useless, as more radical operative measures will be necessary before delivery can be effected.

Methods.—Cephalic version may be brought about either by *external manipulations* alone, or by the combined method. During pregnancy the former is the only method applicable, and at the time of labor it should be employed whenever feasible. The technic has been well described by Pinard, and is somewhat as follows: The patient's abdomen having been bared, the presentation and position of the child are carefully mapped out. The fœtal poles are then seized with either hand, and the one which we wish to present is gently stroked toward the superior strait, while the other is moved in the opposite direction. After version has been completed, the child will tend to return to its original position unless engagement occurs; but at the time of labor the head may be pressed down into the superior strait and held firmly in position until it becomes fixed under the influence of the uterine contractions.

At the time of labor, if external manipulations prove futile, cephalic version may be accomplished by the *combined or bipolar method of Braxton Hicks* as soon as the cervix is sufficiently dilated to admit of two fingers. It, however, is rarely employed, as in such circumstances, it is usually advisable to wait until the cervix is fully dilated, and then to rupture the membranes and do a podalic version followed by extraction. For carrying out the former procedure Hicks gave the following directions:

"Introduce the left hand into the vagina as in podalic version. Place the right hand on the outside of the abdomen in order to make out the position of the fœtus and the direction of the head and feet. Should the shoulder, for instance, present, then push it with one or two fingers on the top in the direction of the feet. At the same time pressure by the other hand should be exerted upon the cephalic end of the child. This will bring the child close to the os. Then let the head be received upon the tips of the inside fingers. The head will then play like a ball between the hands, and can be placed at almost any part at will. . . . It is well, if the breech will not rise to the fundus readily and the head is fairly in the os to withdraw the hand from the vagina and with it press up the breech from the exterior" (Fig. 443). While the credit for popularizing this procedure undoubtedly belongs to Hicks, it is interesting to note that it had been described by Marmaduke Wright, of Cincinnati, in 1854; ten years before the appearance of Hicks's first publication, but had remained buried in an obscure publication.

Busch, D'Outrepont, and others advocated attempting cephalic version after complete dilatation of the cervix, by introducing one hand into the uterus and seizing the head, while the other is employed for external manipulations. This, however, is no longer done, as in such circumstances it is preferable to perform internal version, which is no more dangerous, and at the same time permits immediate delivery if necessary.

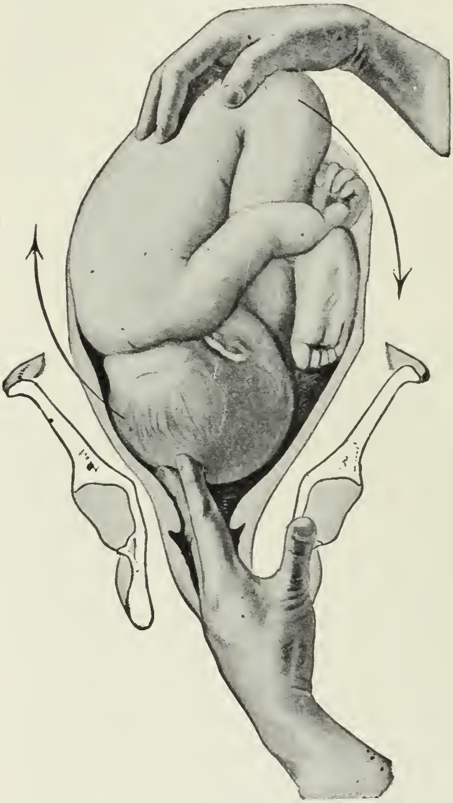

Fig. 443.—Bipolar Podalic Version (Bumm).

Podalic Version.—By this is understood the turning of the child by seizing one or both feet, and drawing them through the cervix, the operation being usually followed by extraction. Podalic version was introduced and warmly advocated by Paré, and, until the invention of the forceps, afforded the only means of artificially delivering unmutilated children. It is interesting to note that Guillemeau, one of Paré's students, was enabled by this means to save his master's daughter from dying of hemorrhage due to placenta prævia. The value of the operation was recognized and insisted upon by Louise Bourgeois, Mauriceau, and among many others by De la Motte, who employed it very frequently with excellent results.

Indications.—Podalic version is indicated in two great groups of cases—namely, in transverse or oblique presentations, and in all varieties of head presentations in which it is believed that delivery can be more safely and more rapidly accomplished after version.

The necessity for version in transverse and oblique presentations is obvious. In abnormal head presentations, when the face, brow, or occiput is posterior and movable above the superior strait, delivery can frequently be more readily accomplished after version than by any other means. Podalic version is usually the operation of choice in prolapse of the extremities or umbilical cord, and in many cases of placenta prævia. Moreover, when the child presents some deformity, delivery is sometimes very much facilitated after version. Generally speaking, the operation is indicated in all cases requiring prompt delivery when the head is floating at the superior strait or is but slightly engaged, provided there is no great disproportion between its size and that of the pelvis. In such circumstances it is usually a safer and more satisfactory procedure than the application of high forceps.

One of its widest fields of usefulness is in accouchement forcé, after the cervix has been completely dilated by means of the hand or by the balloon, especially in preëclamptic toxemia and antepartum hemorrhage. In such circumstances, the presenting part having been displaced during the manipulations employed for dilating the cervix, version and extraction constitute the readiest and most conservative method of delivery.

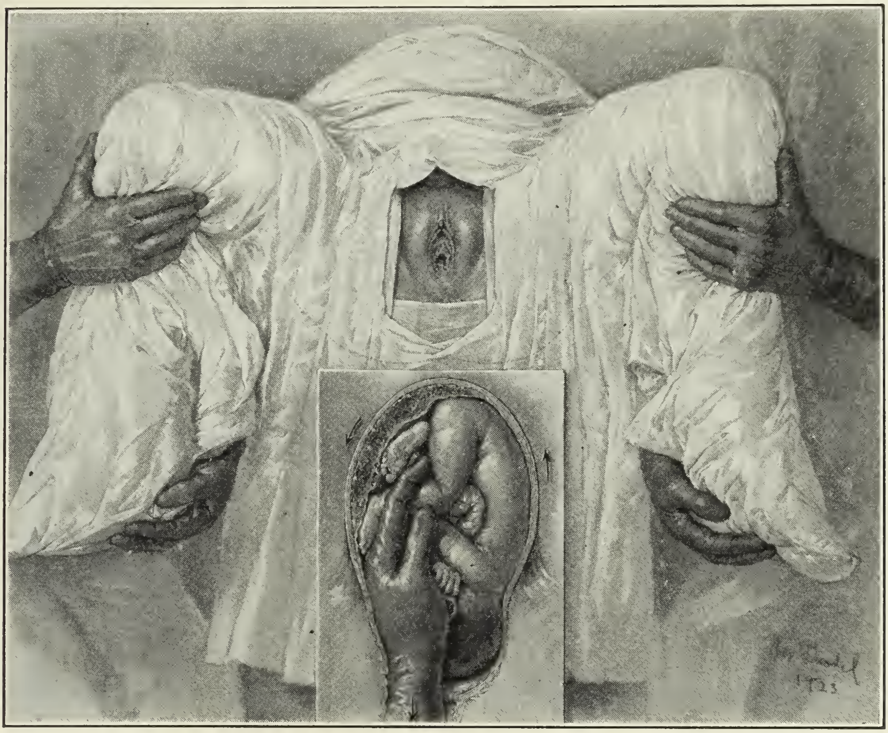

Fig. 444.—Patient in Position for Internal Podalic Version. Inset Shows Hand in Uterus Grasping the Feet.

The most favorable time for performing podalic version is just after the cervix has become fully dilated, but before the membranes have ruptured. In this event, the amniotic fluid will be still *in utero* and the child readily movable in any direction. On the other hand, it should never be attempted when the child is suffering from hydrocephalus, nor when the cervix is imperfectly dilated, except in certain cases of placenta prævia, when the bipolar method of Braxton Hicks is employed. It sometimes happens that the patient is not seen until long after rupture of the membranes, and conditions may then be present which render the operation extremely difficult or even impossible. For example, the uterus may be tetanically contracted and so tightly applied to the body of the child as to render even the introduction of the hand extremely difficult. In other cases, the contraction ring may have risen to such an extent and the lower uterine segment be so stretched as to render the operation dangerous in the highest degree, as the attempt at version will probably lead to rupture of the uterus.

Before cesarean section had become a reasonably safe procedure, many authorities practiced so-called "prophylactic version" in the treatment of moderate degrees of pelvic dystocia. In this the child was turned and extracted as soon as the cervix had become fully dilated, with the idea that the head would withstand momentary compression during the extraction better than continued pressure against the pelvic brim in a long second stage. The operation is no longer employed for two reasons: first, on account of its relatively poor fœtal results, and second, because it converted all such cases into operative labors, and deprived nature of the chance of demonstrating what she could accomplish.

Within recent years Potter of Buffalo has advanced the revolutionary doctrine that all labors not complicated by serious disproportion, should be ended by version and extraction, in the belief that by so doing the duration of labor is shortened, the patient is spared unnecessary suffering, and the danger to the child is not increased. In his monograph, which appeared in 1922, he stated that he had performed over four thousand versions, and during the two years ending August 31st, 1921, had delivered 2253 patients in private practice, as follows: 1858 by version, 180 by cesarean section, 64 by forceps, 130 by various procedures, while only 31 were delivered spontaneously. In other words, 98.2 per cent were delivered by operative means, while the remaining 1.8 per cent escaped only because their labors had ended spontaneously before his arrival.

As far as can be gathered from his writings, as soon as the cervix is partially dilated and offers but little resistance, Potter completes its dilatation manually, and without removing the hand from the uterus, ruptures the membranes and turns and extracts the child.

If his claims are substantiated, he will have effectively revolutionized obstetrics and will have converted childbirth from a physiological and in great part spontaneous process into a routinely operative one. Furthermore, he will have done away with the necessity for any knowledge of the mechanism of labor and in great part with everything formerly taught concerning the practice of obstetrics. He may be right, but I doubt it. Of two things, however, I am sure: first, that he is an extraordinarily accomplished operator, and second that should his practice become generally adopted the mortality from childbirth will increase, and many more children will perish than at present.

Unfortunately, in his monograph, he is more concerned with the technic of the operative procedure than with the ultimate results to his patients. He does, however, state that during the year 1920, 41 children were stillborn and 34 others died during the two weeks following delivery; a mortality of 6.73 per cent which does not commend his practice, as in the first ten thousand deliveries in our service the fœtal mortality was practically the same—namely 7 per cent. When, however, it is remembered that Potter's clientele is composed of private patients, in whom syphilis and contracted pelvis occur comparatively rarely, while ours consists of public ward patients, of whom one half are black, while many are admitted after hours or days of neglect and sometimes in a moribund condition, the contrast is not flattering. Furthermore, when it is recalled that the majority of our patients were delivered by a succession of young men learning the rudiments of their art, while Potter's patients were delivered by probably the most dexterous obstetrical operator in the world, only one of two conclusions can be drawn: either that dexterity and training count for nothing, which is contrary to all experience, or that some inherent defect in Potter's practice counterbalances such advantages.

I am convinced that the latter is the case, as I know from my own experience that in routine version and extraction technical difficulties will occasionally be encountered, which will inevitably increase the fœtal mortality. For these reasons I advise against any wide acceptance of Potter's teaching; but at the same time, it must be admitted that it has rendered an important service by forcibly bringing to the attention of the American profession the merits of a valuable procedure which was in a fair way of being forgotten; as well as to make several important contributions to its technic.

Technic.—For the performance of internal podalic version the patient should be placed upon a suitable table and the usual preoperative preparations made. She should not be placed in the usual obstetrical posture, but instead the legs should be spread widely apart and held by assistants at about the same level as the body (Fig. 444). Version should never be attempted without an accurate diagnosis as to the presentation and position of the child nor as to the existence of disproportion between its size and that of the pelvis. Its performance will be greatly facilitated by the use of long rubber gloves reaching to the elbow, as recommended by Potter, and by an extensive preliminary "ironing out" of the vaginal outlet and pelvic floor. Version is easiest effected while the membranes are intact, and becomes increasingly difficult with every half hour after their rupture.

The operative technic varies somewhat, according as one has to do with a head or a transverse position. In the first instance the hand and arm must be introduced considerably farther into the birth canal than in the latter, which is facilitated by free lubrication of the operating hand and arm by albolene or green soap. It is usually taught that the choice of the hand to be employed depends upon the location of the small parts, and that if the back be directed to the left, the feet can be most conveniently seized with the left hand, and vice versa. Potter, however, has taught us, and I agree with him, that the left hand can be used equally satisfactorily no matter what the position of the feet may be.

Accordingly, if the membranes are still intact, the left hand is passed through the cervix and carried up into the uterine cavity until it reaches the neighborhood of the feet. The membranes are then ruptured, and if possible both feet are seized as shown in the inset to Fig. 444, and downward traction is made. Ordinarily the child turns without difficulty, so that the feet are readily brought down into the vagina, and thence through the outlet. When the knees emerge, one knows that version has been effected, after which delivery is completed by extraction as already described.

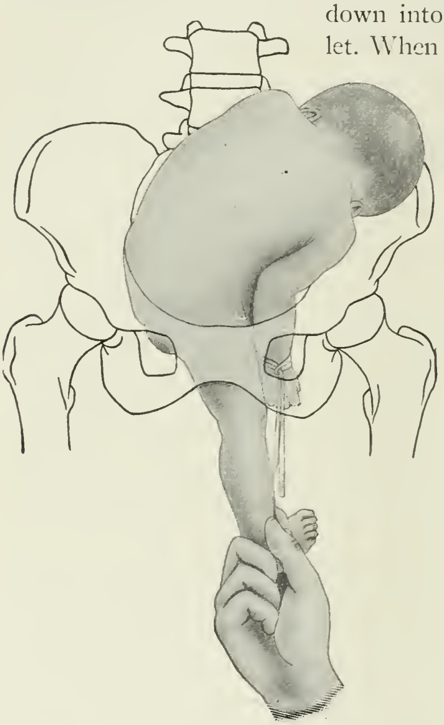

Fig. 445.—Version; Transverse Presentation, Back Anterior, Seizure of Lower Foot.

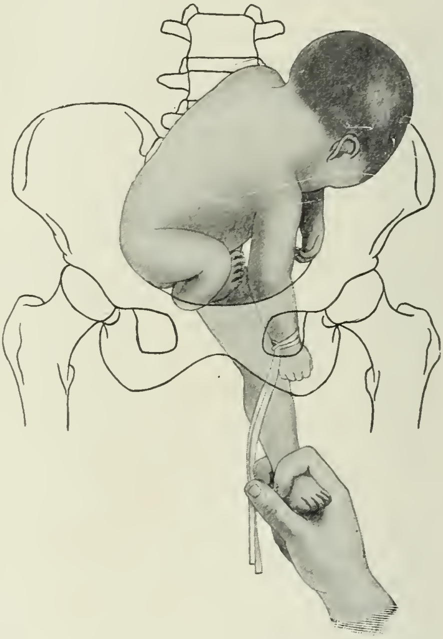

Fig. 446.—Version; Transverse Presentation, Back Anterior, Seizure of Upper Foot.

The seizure of both feet materially facilitates the operation; so that if at first only one can be seized it should be brought through the cervix and the hand immediately reintroduced into the uterus in order to grasp and bring down the other. Indeed, it should be the rule not to attempt to complete the version until both feet are available.

If the membranes have already ruptured and the head is engaged, version is always more difficult. In this case after pushing the head out of the pelvic brim, the hand should be introduced past it, when the feet are seized and brought down as before. Of course, if the amniotic fluid has long since drained off, and the uterus is tightly applied over the child, this may be difficult or impossible, and if persisted in after the lower uterine segment has become markedly stretched may result in rupture of the uterus.

In transverse presentations, it is likewise desirable to bring down both feet, but, in case this cannot readily be accomplished, one foot will suffice. In this event, however, the choice of the foot is a matter of very considerable importance. When the back is directed anteriorly, the lower one should be seized, as by so doing the back of the child is kept directed toward the symphysis; whereas, if the upper foot be seized, the back may turn in the opposite direction. On the other hand, when the back looks posteriorly, the upper is the foot of choice, since traction upon it will cause the back to rotate to the front; while, if the lower foot be seized, although anterior rotation will usually occur, the upper buttock is liable to impinge upon the anterior portion of the pelvic brim, and great force may become necessary to effect its dislodgment (Figs. 445, 446, 447 and 448).

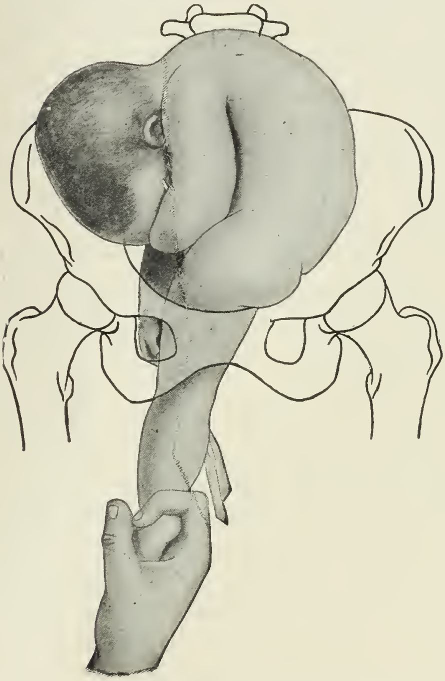

FIG. 447.—VERSION; TRANSVERSE PRESENTATION, BACK POSTERIOR, SEIZURE OF UPPER FOOT.

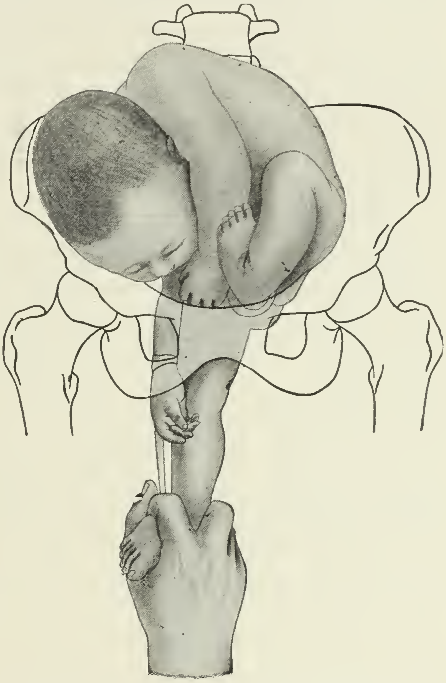

FIG. 448.—VERSION; TRANSVERSE PRESENTATION, BACK POSTERIOR, SEIZURE OF LOWER FOOT, SHOWING ARREST OF BUTTOCKS AT THE PELVIC BRIM.

Not a few cases of transverse presentation are complicated by the prolapse of an arm into the vagina. In such circumstances, a fillet should be applied around the wrist and held loosely by an assistant, while version is performed in the usual manner. In this way the arm is prevented from becoming extended over the head. and the necessity of freeing it during extraction is obviated.

Whatever may have been the original position of the child, firm pressure should be exerted upon the fundus of the uterus as soon as extraction is begun, in order to prevent extension of the head or arms, and at the same time to facilitate delivery.

Combined Podalic Version.—Particularly in placenta prævia, version may be attempted by the combined or bipolar method of Hicks, as soon as the cervix is sufficiently dilated to admit two fingers. With these the presenting part is dislodged and pushed upward, while the external hand gradually brings the breech downward toward the external os. As soon as a foot can be felt it is seized by the two fingers and drawn through the cervix. For the time being this finishes the operation, as extraction should not be thought of until the cervix is fully dilated, for it can be effected only at the cost of deep cervical tears (Fig. 443).

Prognosis.—For the mother the prognosis following podalic version is excellent in properly selected cases, provided the patient be in good condition at the commencement of the operation. On the other hand, when attempted in the case of a tetanically contracted uterus, or when the lower uterine segment is overstretched, forcible attempts at version may lead to the rupture of the organ and death.

The prognosis for the child is fairly good, and depends upon the nature of the indication and the difficulty experienced in extraction. On the other hand, if the operation be undertaken through an imperfectly dilated cervix, and the child's head be arrested by the external os, the time required for its extraction is usually so great that death from asphyxiation is inevitable. Moreover, in cases of marked pelvic contraction, the fœtal mortality is very high. In many such cases forcible traction may enable one to deliver the child, but usually not until after the cord has been so long compressed as to have caused pronounced asphyxia and death, not to mention injuries to the head resulting from pressure.

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CHAPTER XXII

CESAREAN SECTION, SYMPHYSEOTOMY, AND PUBIOTOMY

CESAREAN SECTION

In this operation the child is removed from the uterus through an incision in the abdominal and uterine walls. The origin of the term has given rise to a great deal of discussion. It has been generally asserted that Julius Cæsar was brought into the world by this means and obtained his name from the manner in which he was delivered (*a caeso matris utero*). This explanation, however, can hardly be correct, as his mother, Julia, lived many years after her son's birth; and, besides, Julius was not the first of his name, since there is mention of a priest named Cæsar who lived several generations before. The following view, however, would appear to be more plausible. In the Roman law, as codified by Numa Pompilius, it was ordered that the operation should be performed upon women dying in the last few weeks of pregnancy in the hope of saving the child. This *lex regia* as it was called at first, under the emperors became the *lex cæsarea,* and the procedure itself became known as the *cesarean operation.*

History.—The history of cesarean section may be said to extend over five periods; the first lasting from the earliest times to the beginning of the sixteenth century; the second extending from the year 1500 to 1876; the third beginning with the introduction by Porro of amputation of the body of the uterus; the fourth extending from 1882 to the present time, following the description by Sänger, of an accurate technic for suturing the uterine incision; and the fifth beginning with 1907, when Frank devised the extraperitoneal technic. During the first period the operation was occasionally resorted to after the death of the mother, in the hope of saving the child, but it is improbable that it was practiced upon the living woman, although several authorities are inclined to believe that certain passages in the Talmud may be so interpreted. The fact that Felkin saw a cesarean section performed by the natives in Uganda renders it possible that it may have been employed upon the living woman at an early period by certain of the uncivilized races.

The second period begins with the year 1500, when, according to Casper Bauhin, Jacob Nufer, a castrator of pigs at Sigerhausen, Switzerland, operated successfully upon his own wife after she had been given up by the midwives and barbers in attendance. This operation is usually described as the first cesarean section to be performed upon a living woman, but in reality it probably consisted in the removal of an extra-uterine child from the abdominal cavity, as the fact that the woman had five spontaneous labors afterwards speaks strongly against the probability that the operation was necessitated by obstruction due to a contracted pelvis or to a tumor.

François Rousset, a contemporary of Paré, wrote a treatise in 1581, in which he gave the histories of a number of cesarean sections collected from various sources. Several of them were apocryphal while others, in all probability, were operations for advanced extra-uterine pregnancy. His article, however, had the merit of directing attention to the operation and to the possibility of performing it upon the living woman. The first authentic cesarean section was probably done in 1610 by Trautmann, of Wittenberg. Following this, it was occasionally performed until it became temporarily eclipsed by symphyseotomy, in 1777, to be taken up again after the latter operations had fallen into disrepute.

During this period, the uterus was simply incised and the child extracted. The uterine walls were not sutured, the contraction and retraction of the organ being relied upon to check hemorrhage. Most of the women perished from hemorrhage or infection. Sutures were first employed by Lebas (1769), but did not come into general use until after the appearance of Sänger's epoch-making article in 1882.

Before the work of Porro and Sänger, the mortality following the operation was appalling. Meyer (1867) collected 1605 cases from the literature with a mortality of 54 per cent; while in 80 cases performed in the United States up to 1878, collected by Harris, 52.5 per cent of the women died. According to Budin, not a single successful cesarean section was performed in Paris between the years 1787 and 1876. Such poor results were obtained that Harris in 1887 pointed out that the operation was more successful when performed by the patient herself, or when the abdomen was ripped open by the horn of an infuriated bull. He collected 9 such cases from the literature with 5 recoveries, and stated, that out of 11 cesarean sections performed in New York City during the same period, only one patient recovered.

The third period began with the year 1876, when Porro advised amputating the body of the uterus and stitching the cervical stump into the lower angle of the abdominal wound in order to lessen the danger from hemorrhage and infection. Certain writers claim that the credit for this intervention belongs to Storer of Boston, who, in 1861, amputated a myomatous pregnant uterus with fatal result. Inasmuch, however, as he did not appear to recognize the importance of the innovation, the credit for proposing it undoubtedly belongs to Porro. This procedure, being followed by satisfactory results, soon became quite popular, so that in 1890 Harris was able to collect 264 operations from the literature. After the technic for supravaginal amputation of the myomatous uterus had become perfected, similar methods were applied to the Porro operation, the cervical stump being covered by a flap of peritoneum and dropped into the abdominal cavity; while in a small number of cases particularly when the cervix was carcinomatous, the entire organ was removed. The latter procedure, which was first attempted by Bischoff, has but a limited field of application.

The fourth period began with Sänger, who, in 1882, revolutionized cesarean section by insisting upon the necessity for suturing the uterine incision and by describing an accurate technic for the purpose. As the uterus was not sacrificed in this operation, it was designated as the conservative, in contradistinction to the Porro, or radical, cesarean section. With increasing perfection of surgical technic, as well as with better knowledge of the indications for its performance, more and more satisfactory results have been obtained from it, while the radical operation has become less popular.

The fifth period began in 1907 when Frank, of Cologne, who had become dissatisfied with the results following the classical conservative section, particularly in women who had been exposed to the possibility of infection prior to the operation, described a new operative technic. In this procedure a transverse incision is made through the anterior abdominal wall several centimeters above the symphysis and the peritoneum separated from the posterior surface of the bladder and the anterior surface of the lower uterine segment. After proper exposure, the latter is then incised transversely, the child is extracted by forceps, the placenta removed manually, and the wound closed. By this method the entire operation is done extraperitoneally, and, according to its inventor, may be safely employed when conservative section would be contra-indicated.

The extraperitoneal technic was enthusiastically taken up in Germany, and subjected to minor modifications by Latzo, Sellheim and others, while Döderlein resuscitated the operation of laparo-elytrotomy, which had been suggested by Philip Syng Physick and by Baudelocque in 1823, and rehabilitated by Gaillard Thomas in 1871, to be afterward abandoned in favor of the classical cesarean section. After reporting 32 such operations, he in turn abandoned the procedure, as he found that the wound healing was complicated, that drainage was always required and that the operation was not available for use in infected patients. The historical aspects of the question were carefully considered by Küstner in his monograph which appeared in 1915. In it he also described his own modification of extraperitoneal section, based upon a personal experience of 112 operations. In general it may be said that, after a fair trial, the various methods of extraperitoneal section have fallen into disfavor, and have been replaced by the so-called low cervical operation.

Krönig contended that the main advantage of the extraperitoneal technic consisted not so much in avoiding the peritoneal cavity, as in opening the uterus through its thin lower segment and then covering the incision by peritoneum. To accomplish this, he cut through the vesical reflexion of the peritoneum from one round ligament to the other, and separated it and the bladder from the lower uterine segment and cervix. The latter was then opened by a vertical median incision and the child extracted by forceps. The uterine incision was then closed and was buried under the vesical peritoneum. With minor modifications this low cervical technic has become popularized in this country by Beck and DeLee. The latter designates it as laparotrachelotomy, and believes that it should eventually displace the classical conservative operation.

In 1924, Portes described a new type of cesarean section, which he claims is particularly adapted to infected cases in which it is important to preserve the uterus. In this procedure the unopened organ is delivered through the abdominal incision, but is not incised until after the peritoneum has been sutured about its cervical portion and the abdominal wound closed above it. After extracting the child, the uterine incision is sutured, and the exteriorized organ is covered with moist dressings. During convalescence the involution changes can be followed by the naked eye, and five or six weeks later when the uterus has returned to its usual size, the abdominal wound is reopened and the uterus restored to the pelvic cavity. In at least one instance, the patient became pregnant afterwards, and was delivered by classical cesarean section. Phaneuf reports two personal cases, and states that 16 such operations had been reported up to 1927.

Indications.—With the increasing perfection of surgical technic, and an erroneous idea of the safety of the operation, there seems to be a growing tendency to regard cesarean section as the simplest means of coping with most obstetrical difficulties. At the present time I consider that the operation is being abused, and that not a few patients are sacrificed to the *furor operativus* of obstetricians and general surgeons who are ignorant of the fundamental principles of the obstetric art. This being the case, the conscientious obstetrician should be particularly careful in the recognition of indications for cesarean section.

The most frequent, important and unquestioned indication is afforded by serious disproportion between the size of the fœtal head and the maternal pelvis. Formerly, the pelvic indication was designated as absolute or relative, according as the length of the conjugata vera fell below 5 or 7.5 centimeters, respectively. In the former the contraction is so pronounced that the birth of the child is impossible, even after craniotomy, while in the latter spontaneous labor is out of the question and the choice of procedure lies between craniotomy and cesarean section. At present, in view of the satisfactory results following section, this distinction no longer holds, and the operation is absolutely indicated in all pelves measuring 7.5 centimeters or less whenever the full term child is alive, the mother uninfected and amid surroundings suitable for a major operation.

Even when the pelvis falls within the so-called "border line" category—with an upper limit of 8.5 centimeters in flat and 9 centimeters in generally contracted pelves—the operation may likewise be indicated. In pelves of this character, however, the course of labor depends not merely upon the degree of pelvic contraction, but more particularly upon the size and consistence of the head and the character of the uterine contractions. Given two women with pelves and children of the same size, one may have a spontaneous and easy labor, while the other may require radical interference. In the latter event, the operation is undertaken primarily in the interests of the child, instead of resorting to high forceps, version, or craniotomy.

Accordingly, in this class of cases, when examination at the end of pregnancy reveals the existence of serious disproportion between the size of the head and the pelvis, and particularly when the patient presents a history of previous operative labors with dead children, elective conservative cesarean section should be performed at an appointed time before the onset of labor, or within a few hours thereafter, since the prognosis for the mother becomes more serious with every hour interference is deferred. On the other hand, if the patient is first seen late in labor, the low cervical technic is preferable.

Furthermore, when the disproportion is less pronounced and one is uncertain as to the probability of a spontaneous outcome, the patient should be given the test of labor and only subjected to section after several hours of second stage pains have failed to bring about engagement. The term "test of labor" is greatly abused, as many believe that it has been applied if the head does not become engaged after a few hours of first stage pains. To my mind this constitutes no test at all, as it gives no idea as to what may happen after the cervix has become fully dilated. In all such late cases, low cervical section becomes the operation of choice, provided the patient is in good condition and is in the hands of a competent operator. If, however, these conditions cannot be fulfilled, the patient should be allowed to continue in labor until a definite indication for its termination arises, when craniotomy should be performed.

Pelvic contraction involving the superior strait is not the only indication for cesarean section, as in not a few cases abnormalities of the pelvic outlet likewise call for its performance. It is usually stated that a bisischial diameter of 7 centimeters or less affords a positive indication, but it will be pointed out in the section upon funnel pelvis that this does not necessarily hold good. Such a measurement should, however, be regarded as a danger signal, as it indicates so great a narrowing of the pubic arch that spontaneous labor cannot occur unless there be sufficient space between the bisischial diameter and the tip of the sacrum to permit the passage of the head. Accordingly, in such cases, the necessity for interference will depend entirely upon the length of the posterior sagittal diameter of the inferior strait. Other pelvic deformities which occasionally necessitate the operation will be considered in the chapters upon Contracted Pelves.

As will be indicated in greater detail in the appropriate chapters, probably the most clear-cut indication for cesarean section, after pelvic dystocia, is afforded by myomata in the lower segment of the uterus, as well as by ovarian and other tumors, which may so block the pelvic canal as to render radical intervention imperative. The same may be said of certain cases of atresia following cicatricial contractions of the cervix or vagina.

Carcinoma of the cervix occasionally results in the formation of such dense and rigid tissue that dilatation becomes impossible. In such cases, cesarean section is demanded in the interests of both the child and mother, and should be supplemented by total hysterectomy, if the disease be not too far advanced.

In rare instances, malignant tumors of the rectum may so obstruct the pelvic canal as to render cesarean section imperative, and Nijhoff collected the literature upon the subject up to 1905. As a curiosity, it may be mentioned that Jaschke has reported a case in which the pelvic cavity was so obstructed by a megacolon that cesarean section was necessary.

Halbertsma, in 1899, suggested cesarean section as the best method of delivery in certain cases of eclampsia complicated by an undilated and rigid cervix, and since then it has been extensively employed in all parts of the world, but with strikingly unsatisfactory results. In the future, I imagine that it will be used much less frequently for two reasons. In the first place, considerable skepticism has developed concerning the curative effect of rapid delivery in eclampsia; while in the second place the symposium upon its treatment before the British Congress of Obstetrics and Gynecology held in 1922, which was based upon the consideration of 2045 cases, showed that only accouchement forcé gave worse results.

Dudley, in 1900, suggested the advisability of cesarean section in certain cases of placenta prævia, and since the publication of Krönig's work it has been employed with increasing frequency in the central variety. While admitting that it is justifiable in rare instances, I agree with Holmes that, while it may diminish the fœtal death rate, it would, if generally employed, considerably increase the maternal mortality.

Following the discovery that in premature separation of the normally implanted placenta the uterine musculature may be markedly dissociated by hemorrhage, cesarean section appears to be the operation of choice in that condition whenever the cervix is not dilated. Furthermore, if the organ fails to contract after it has been emptied, the operation should be completed by supravaginal hysterectomy.

In certain cases of pregnancy complicated by uncompensated heart lesions, cesarean section often affords the most conservative method of effecting rapid delivery, and the uterus should be amputated upon its conclusion as the most satisfactory method for preventing the occurrence of pregnancy in the future.

Reynolds has advocated cesarean section in the absence of pelvic contraction, or of any other mechanical indication, in women who appear to be mentally or physically ill-equipped to bear the strain of childbearing. Other writers have recommended its performance as a means of overcoming dystocia due to face, brow or transverse presentations; while still others have taken the extreme ground that it may even be justifiable in breech or obliquely posterior occipital presentations. While it may be admitted that in peculiar circumstances such indications may occasionally hold good, I cannot but feel that their advocacy has done great harm, and has afforded poorly trained physicians justification for reckless and unnecessary operating. The following table gives the percentage incidence of the several indications for 349 sections done in my service between January 1, 1920, and April 1, 1929:

	Per Cent
Contracted pelvis	72.8
Premature separation of placenta	6.9
Toxemia (not eclampsia)	6.3
Tumors	3.4
Elderly primiparæ	2.01
Eclampsia	1.15
Heart disease	0.86
Placenta prævia	0.57
Various	6.02
	100.01

As it is generally believed that the cicatrix following a cesarean section represents a locus minoris resistentiæ and may rupture during a subsequent pregnancy, many writers have laid down the dictum—"once a cesarean, always a cesarean." As will be pointed out in the appropriate place, I do not entirely agree with such teaching. Naturally such a uterus is less efficient than one which has never been incised, and to my mind that fact should be regarded as a potent argument against the use of cesarean section for nonpelvic indications, except in the most pressing conditions.

Contra-indications.—Except in the presence of an absolute pelvic indication, cesarean section should never be performed when the child is dead or in serious danger. It is likewise contra-indicated when the mother is in poor condition, or among surroundings which render an aseptic operation impracticable. In such circumstances, craniotomy is the operation of choice. Again, the classical operation is contra-indicated when the patient is already infected, has been long in labor, or subjected to repeated vaginal examinations by those whose technic is questionable, even though no signs of infection are apparent at the time. If the patient is definitely infected, the body of the uterus should be amputated after delivery of the child, but in the other conditions just mentioned low cervical section is followed by better results than the classical operation.

Operative Technic.—(*a*) *Conservative Cesarean Section.*—The operation will give almost ideal results if performed at an appointed time, a day or so prior to the end of pregnancy, or within a few hours after the onset of labor; whereas the prognosis becomes progressively worse for every hour it is deferred.

When the operation can be performed at a fixed time, the patient should be prepared exactly as for an ordinary abdominal operation. On the night before, she should receive a full bath and the abdomen and pubic hairs should be shaved. The bowels should be evacuated by an appropriate cathartic, and an enema given a few hours before she is put upon the table. If the patient is not seen until labor has set in, similar preparations should be made, except that the bath and the administration of a cathartic must, of course, be dispensed with.

Just before the beginning of the operation, the bladder is catheterized and the abdomen disinfected by means of tincture of iodine and alcohol. The woman being in the dorsal position, the entire body, except the field of operation, is covered with sterile dressings. In addition to the operator, four assistants are needed, one to give the anesthetic, one to assist directly at the wound, and two to handle the instruments. With the exception of the anesthetist, all should wear rubber gloves, and sterile gowns and masks. A competent person should be charged with the reception and care of the child and receive careful instructions as to the best method of resuscitating it, if necessary. The following instruments are required: 1 scalpel, 1 long blunt-pointed scissors, 2 dissecting forceps, 12 short and 6 long artery clamps, abdominal retractors, a needle holder and appropriate needles, as well as the usual sterile dressings, suture materials, and gauze sponges.

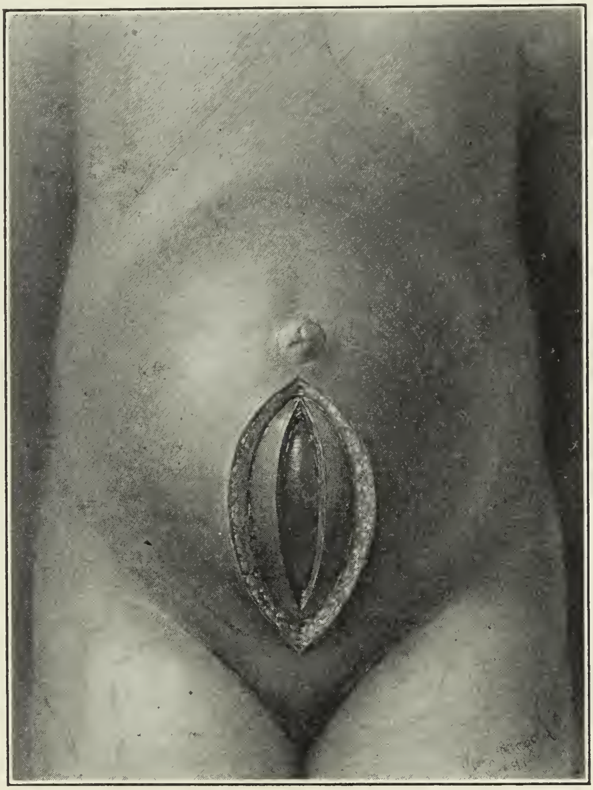

Fig. 449.—Conservative Cesarean Section.
Diagram showing location and extent of the abdominal and uterine incision.
Distended fœtal membranes visible through uterine incision.

An incision 15 centimeters long should be made in the linea alba, beginning just below the umbilicus. The abdominal walls are usually quite thin and bleed little, rarely more than three or four clamps being required to check hemorrhage. The uterus is found directly beneath the incision. If deflected to one side, its long axis should be brought into correspondence with the abdominal incision. and gauze packs, moistened with sterile salt solution, inserted between it and the margins of the abdominal incision, so that the possibility of contaminating the peritoneal cavity may be reduced to a minimum. If there is no likelihood of infection, the uterus should be opened in situ; otherwise the incision should be sufficiently enlarged upwards to permit delivery of the organ from the abdominal cavity, and in this contingency it should not be cut into until the edges of the wound have been clamped together above the cervix and covered with sterile towels.

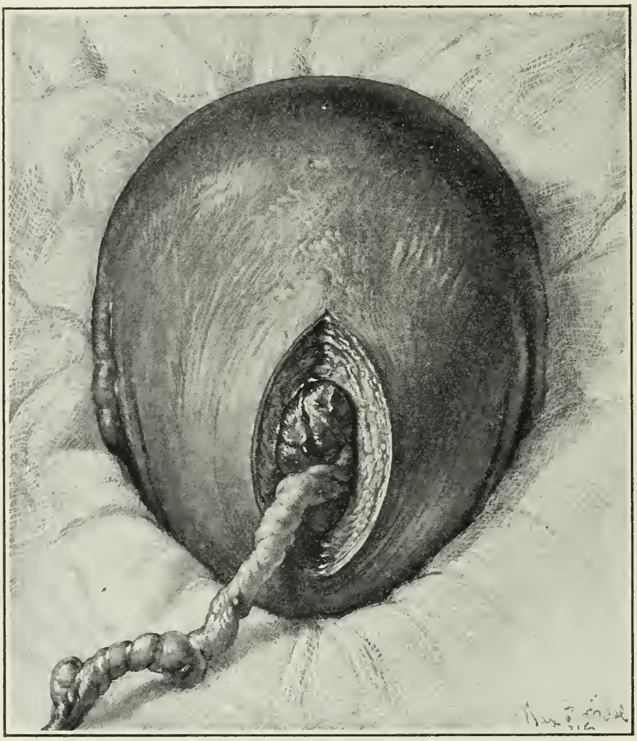

Fig. 450.—Conservative Cesarean Section.
Contracted uterus delivered through the abdominal wound and packed off with gauze compresses. Placenta still in situ. × ⅔.

In order to insure satisfactory contraction of the uterus, and thus minimize the amount of bleeding, 1 cubic centimeter of pituitary extract should be administered hypodermically just before the uterus is incised. The anterior surface of the uterus is opened longitudinally along its midline with the lower end of the incision terminating just above the reflexion of the bladder peritoneum. This is best accomplished by making an incision a few centimeters long with a scalpel, and then rapidly enlarging it with the scissors to 15 centimeters. The membranes are then ruptured, the child is seized by one foot and extracted. Two clamps are applied to the cord, which is cut between them, and the child handed to an assistant. This takes but a short time, and it is rare for more than ninety seconds to elapse between the beginning of the operation and the birth of the child. Many authorities recommend that an attempt be made to locate the position of the placenta beforehand, so that the incision may be made in such a way as to avoid it. This, however, is not necessary. If the placenta lies under the incision, as it does in two cases out of five, it should be rapidly cut through or pushed to one side and the child extracted. This is accompanied by a slight increase of hemorrhage, but as the bleeding is only momentary, it is without significance. Immediately after the delivery of the child, the uterus contracts down and hemorrhage practically ceases. The uterus should then be delivered through the abdominal incision, and the peritoneal cavity posterior to it protected by gauze napkins. If the placenta and membranes have not become separated spontaneously, they should be peeled off and removed with the hand, care being taken that no shreds of membranes are left behind. Disinfection of the uterine cavity is not necessary. Even when the operation is undertaken before

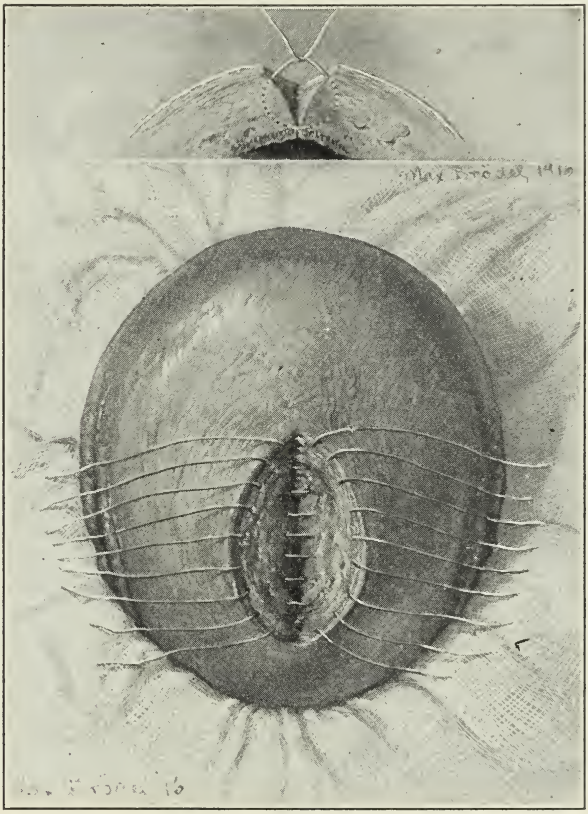

FIG. 451.—CONSERVATIVE CESAREAN SECTION.
Placenta has been delivered and deep sutures laid. The upper sketch shows the bite of the suture which avoids the decidua and the external layer of muscles. × ⅔.

the onset of labor, it is not necessary to dilate the cervix artificially, as the canal is always sufficiently patulous to permit free drainage.

The uterine wound is now closed by deep and superficial formol or chromicized catgut sutures. The former are placed at intervals of about 1 centimeter. They are introduced by means of a large curved needle just beneath the thin superficial muscular layer, and extend through the entire thickness of the muscularis, avoiding the decidua. They are then tied and cut short, after which the superficial muscular layer and peritoneum are brought together over them by a continuous suture. This is readily accomplished, and is preferable to the original procedure of Sänger, in which small flaps of peritoneum were formed by excising a thin layer of muscle from either side of the wound. Any blood which may have escaped into the pelvic cavity is then carefully sponged out, and the abdominal wound closed. This is best accomplished by suturing the peritoneum, muscles, fascia, and skin in separate layers. When the abdominal walls are fat, as well as in patients who are unlikely to exercise self-control during conva-

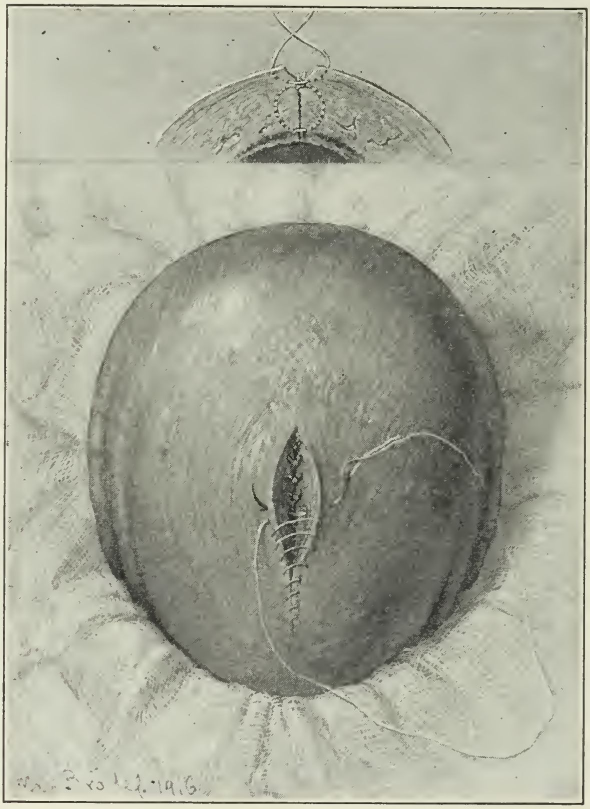

FIG. 452.—CONSERVATIVE CESAREAN SECTION.
The deep sutures have been tied and cut, and the superficial layer of muscle and peritoneum are being brought together by a continuous suture. The upper sketch gives further details.

lescence, it is advisable to lay 3 or 4 silkworm-gut stay sutures as soon as the peritoneum is closed. These should be introduced through the skin 2.5 centimeters from the margins of the incision and involve the subcutaneous fat, fascia and muscle. Their outer ends should be covered with thin rubber tubing to prevent damaging the skin. Should infection occur, such stay sutures may prevent the entire wound from opening up with subsequent escape of the intestines.

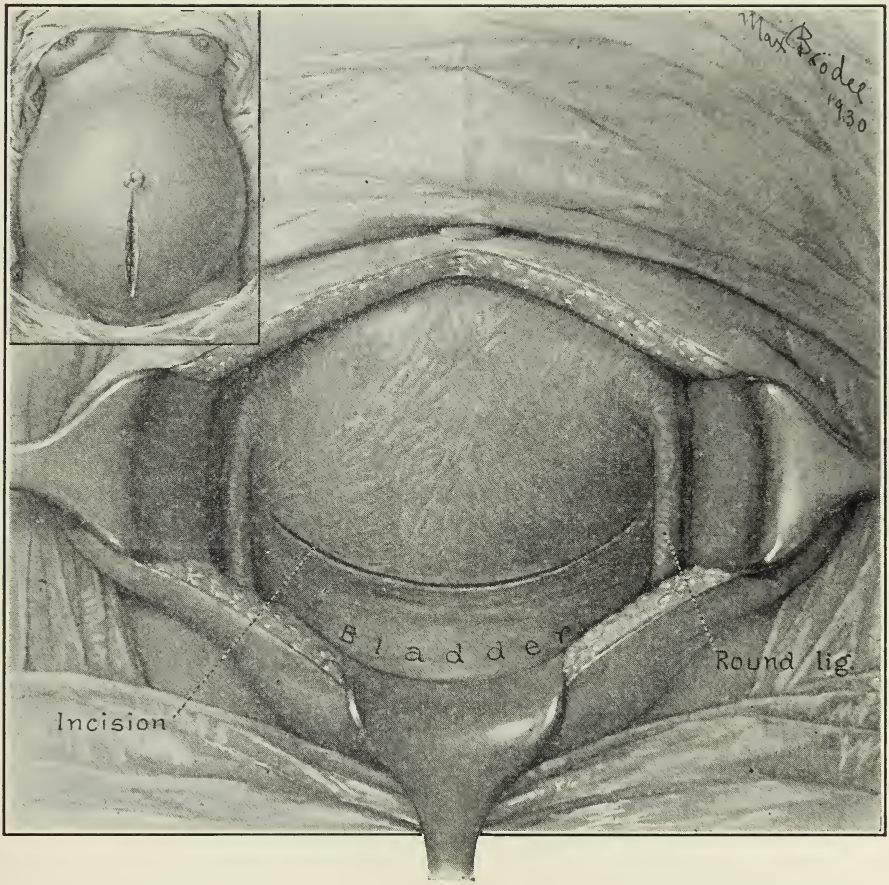

Fig. 453.—Low Cesarean Section, Anterior Surface of Uterus Exposed. Transverse incision of peritoneum at uterovesical junction. Insert in upper left corner shows extent of original abdominal incision.

In the early days of cesarean section, the possibility of hemorrhage was greatly feared, and, to prevent it, Litzmann recommended that an elastic ligature be applied about the cervix before opening the uterus. This is, however, an unnecessary precaution; nor is it devoid of danger, as the prolonged compression predisposes to uterine atony and to hemorrhage afterward. If, however, there is considerable loss of blood after the delivery of the child, the assistant should grasp the cervix firmly between his fingers and thus compress the uterine arteries. This effectually controls hemorrhage and is preferable to the employment of a rubber ligature.

Fritsch, in 1897, proposed opening into the uterus through a *transverse incision* over the fundus, instead of by the usual method, holding that, the course of blood vessels in that location being parallel to the incision, the hemorrhage would therefore be less. His proposal was at once tested by many operators. The results were excellent, but not better than those following the more usual incision.

There would appear to be no advantage in adopting Fritsch's suggestion, except perhaps in the small number of cases in which it is desired to sterilize the patient by excising the tubes. It is urged that the fundal wound is less likely to be followed by adhesions between the uterus and the anterior abdominal wall. This is no doubt correct, but at the same time, should infection occur with the transverse incision, virulent material is more liable to gain access to the general peritoneal cavity; while, if it occurs with the longitudinal incision, the abscess has more chance of opening through the abdominal wound.

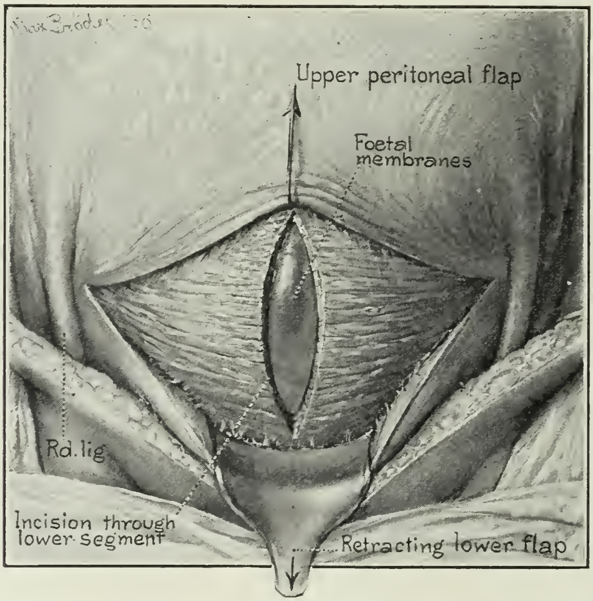

Fig. 454.—Low Cesarean Section; Peritoneal Flaps Retracted. Lower uterine segment exposed, with fœtal membranes bulging through vertical incision in its midline.

Asa B. Davis has recommended that the abdominal incision be made entirely above the umbilicus, and that the uterus be incised high up corresponding to it. Notwithstanding his advocacy, I see no advantage in the high incision, but instead several disadvantages. In the first place, should amputation of the body of the uterus become necessary, and one can never predict when it may become imperative, it will be necessary to enlarge the incision downwards. In the second place, it seems inadvisable to recommend one type of incision for the classical, and another for low cervical and radical sections, as a low incision is essential to the latter technic.

(*b*) *Low Cervical Cesarean Section.*—This operation, which is sometimes called laparotrachelotomy, represents the eventual evolution of the so-called extraperitoneal technic. While somewhat more difficult than the classical operation, it gives excellent results, and is the procedure of choice whenever cesarean section is performed six or more hours after the onset of labor. If, however, the patient shows signs of actual infection, as indicated by elevation of temperature and rapid pulse, much better maternal results are obtained if the body of the uterus is amputated.

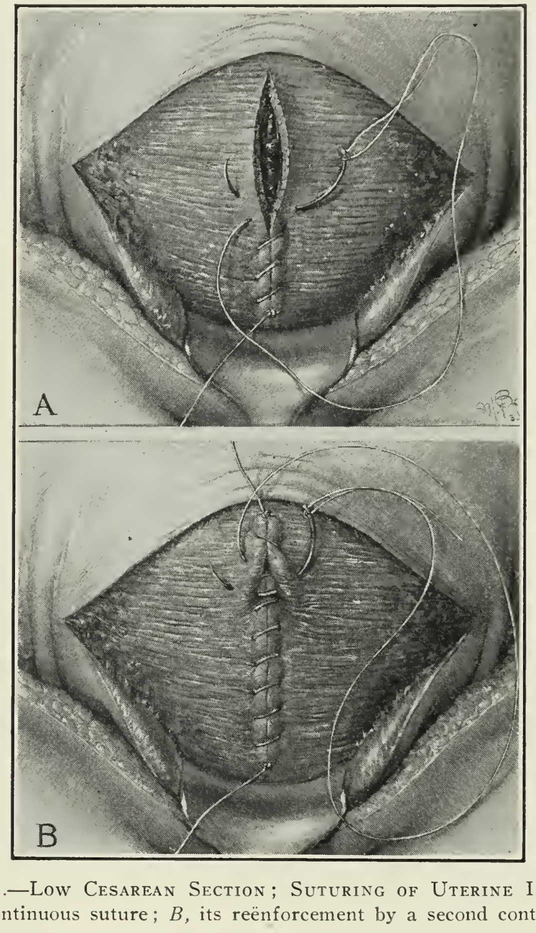

Fig. 455.—Low Cesarean Section; Suturing of Uterine Incision.
A, the first continuous suture; *B,* its reënforcement by a second continuous suture.

After emptying the bladder by catheter, the patient is placed in a moderate Trendelenburg posture, and the abdomen opened in the midline just as in the classical operation. The margins of the abdominal incision are then drawn apart by suitable retractors, and the lowermost portion of the uterus exposed. The loose peritoneum is seized by dissecting forceps just below its firm attachment to the anterior wall of the uterus and, together with the tissue just beneath, incised transversely by scissors for almost the entire distance between the round ligaments (Fig. 453). Then, by means of a small sponge stick, or a finger covered with gauze, the peritoneum and posterior surface of the bladder are separated from the uterine wall. In this way two flaps are formed, a short upper one, which terminates where the peritoneum is firmly attached to the uterine body, and a longer lower one which consists of the vesical peritoneum and the posterior surface of the bladder. The midline of the lower flap is then caught with a suture or an Allis clamp, and when the flap is drawn up against the symphysis by a suitable retractor, the entire lower uterine segment and upper part of the cervix becomes exposed. A small nick is then made in its midline with a scalpel and the incision is prolonged with scissors until sufficiently large to permit the passage of the child's head (Fig. 454). It is well to catch the lower angle of the incision by a suture or an Allis clamp in order to facilitate its relocation later, after which the lower retractor is removed. By means of a finger in the mouth the head of the child is rotated until the face comes to occupy the uterine incision, when delivery is effected by means of a short pair of forceps, or by passing the hand under the occipital region, aided by pressure upon the fundus of the uterus.

Pituitary extract is administered just before the child is delivered, and after its delivery the placenta is expressed or removed manually. An Allis clamp in the upper angle serves to make the incision taut, and its thin walls are brought together by a continuous catgut suture, which it is well to reënforce by a second suture which does not penetrate the uterine wall (Fig. 455). All clots are carefully removed by means of sponge sticks, the upper peritoneal flap is brought down and sometimes attached to the uterus by one or two interrupted sutures, after which the lower flap is brought into place and united to the upper by a continuous catgut suture, and the abdominal wall closed in layers without drainage (Fig. 456).

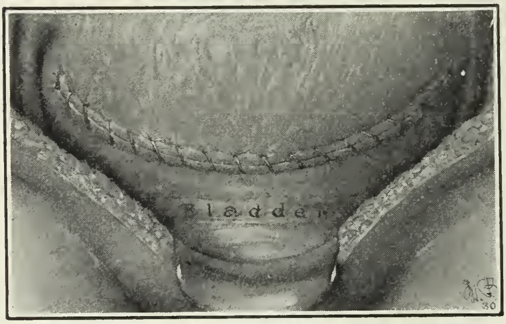

FIG. 456.—LOW CESAREAN SECTION; PERITONEAL FLAPS UNITED BY A CONTINUOUS SUTURE.

Instead of incising the uterus vertically, Monro Kerr advocates making the incision tranversely. I have tried both methods, and find the latter incision somewhat easier to suture, but believe that it is sometimes accompanied by greater hemorrhage due to injury to small vessels at the margins of the lower segment.

During the entire procedure the uterus remains in situ, and if the anesthetic is well given, the intestines and uterine appendages at no time come into view. Ordinarily, the hemorrhage is not excessive, but occasionally, and particularly when the uterine incision diverges from the midline, it may prove troublesome. If the patient was not infected before the operation the convalescence is very satisfactory, and in some respects smoother than after the classical operation.

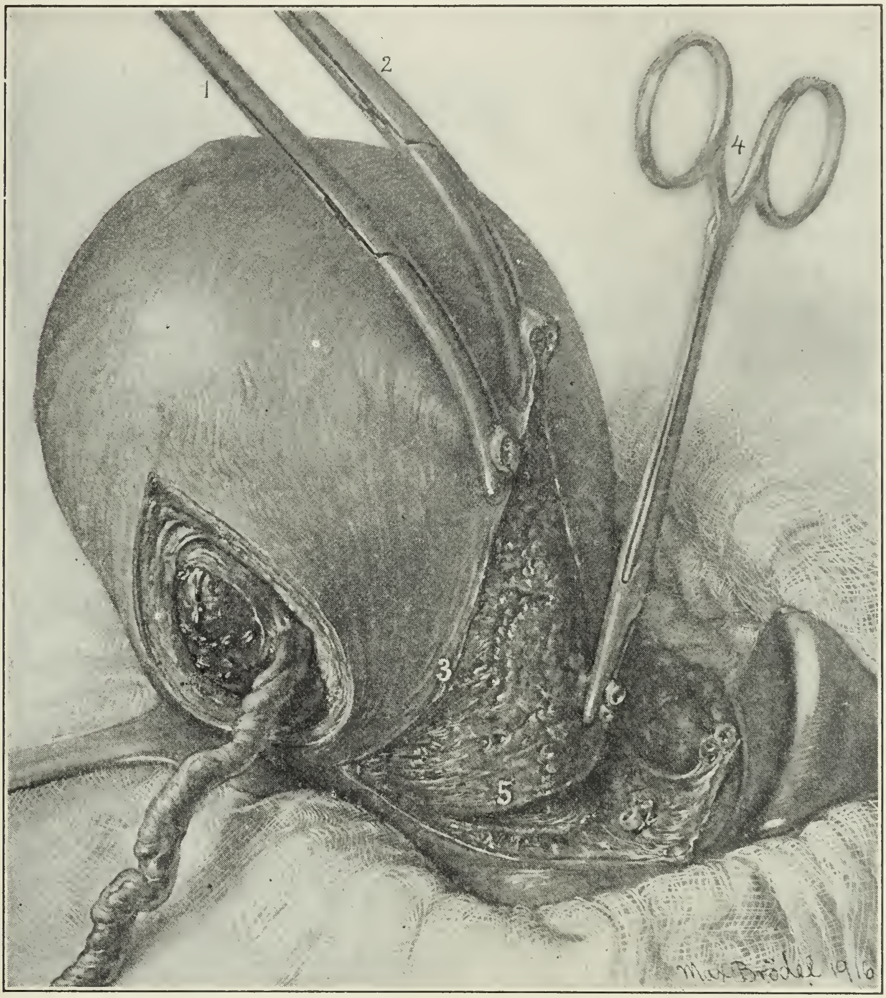

FIG. 457.—CESAREAN SECTION FOLLOWED BY SUPRAVAGINAL HYSTERECTOMY, WITH RETENTION OF TUBES AND OVARIES. PLACENTA STILL IN UTERO.

1, Clamp applied to round ligament; *2*, clamp applied to proximal end of tube and broad ligament; *3*, anterior peritoneal flap; *4*, clamp applied to proximal end of uterine artery; *5*, transverse incision through cervix. × 1.

(*c*) *Extraperitoneal Cesarean Section.*—In appropriate cases, satisfactory results may be obtained by Küstner's technic. I occasionally employed it in the past, but as it is more difficult to perform, and apparently presents no advantages over the low cervical operation, I have ceased to make use of it.

(*d*) *Porro, or Radical Cesarean Section.*—Until after the delivery of the child, the operative steps are identical whether the uterus is to be retained or its body is to be amputated. If, however, the latter is to be done, it is unnecessary to remove the placenta. In the original Porro operation, the technic is as follows: As soon as the child is delivered an elastic ligature is tightly tied around the upper portion of the cervix. The infundibulopelvic ligaments are then ligated and cut through, after which the uterus is amputated a short distance above the rubber ligature. To prevent the stump from slipping backward, a long knitting needle is passed through it and allowed to rest upon the abdominal walls.

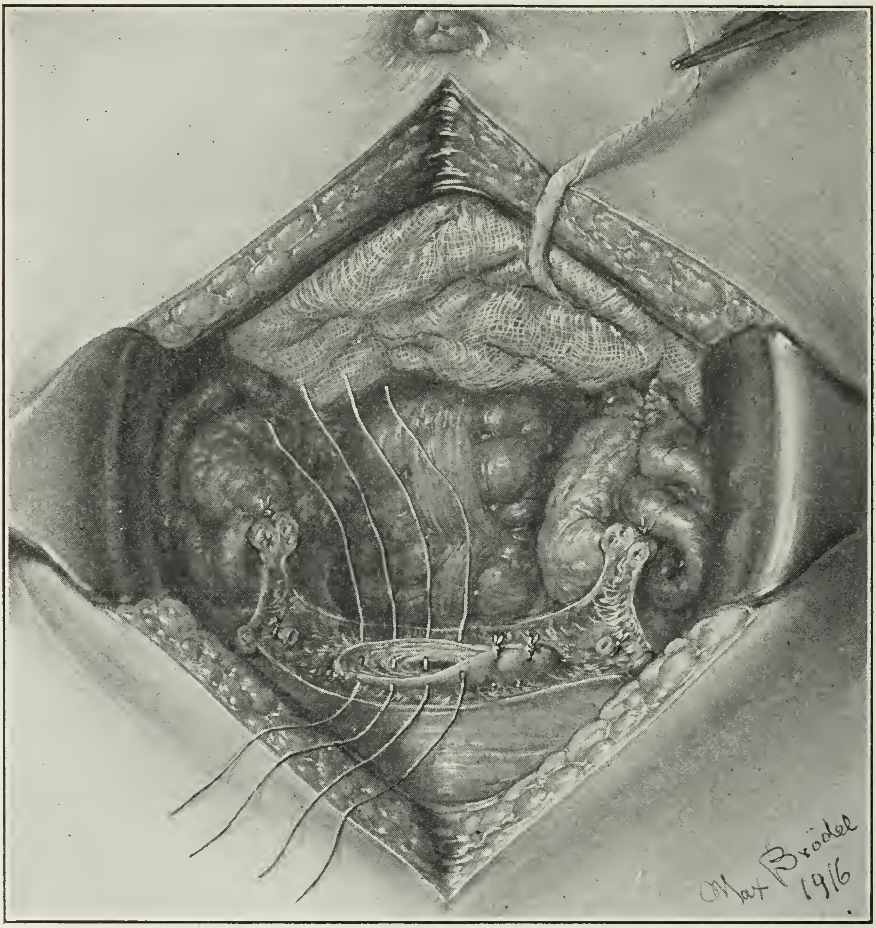

Fig. 458.—Cesarean Section Followed by Supravaginal Hysterectomy. Note the tubes and ovaries in situ; the method of suturing the cervical stump, and the broad ligament wound which will later be closed by a continuous suture. × 1.

The stump is then sewed into the lower angle of the abdominal wound, the remainder being closed in the usual manner. Within a short time the stump and elastic ligature slough off, leaving a depressed wound which heals by granulation. This operation is readily performed, but is rarely employed at present, because of the complicated healing, and the indrawn scar which results.

At present, when it is desirable to remove the body of the uterus, the same technic is employed as in an ordinary supravaginal hysterectomy with retention of the ovaries, and is greatly facilitated by placing the patient in the Trendelenburg posture. After the uterus has been delivered from the abdominal cavity, the tubes, ovarian and round ligaments on either side are ligated a short distance from the uterus, clamped still nearer to it, and severed. With a single stroke of the scissors the broad ligament on either side is cut through down to its base. An elliptical incision is then made through the peritoneum on the anterior surface of the uterus, just above the bladder, and a peritoneal flap rapidly peeled off by means of a piece of gauze applied around the end of the finger or by the handle of a scalpel. The uterine arteries are then isolated, ligated, and severed, after which the body of the uterus is amputated. The cervical stump is brought together by the necessary number of catgut sutures, covered by the peritoneal flap, and is then dropped into the pelvic cavity. The openings in the broad ligaments are closed by continuous catgut sutures, the pelvic cavity is sponged out, and the abdominal wound closed (Figs. 457 and 458).

The operation is readily performed, and can be completed in as short a time as a conservative cesarean section; for, owing to the laxness of the pelvic floor and the abdominal walls, the upper portion of the cervix can be brought through the incision and the entire operation completed upon the surface of the abdomen.

(*e*) *Total Hysterectomy.*—Bischoff was the first to remove the entire uterus after cesarean section, and, under thoroughly aseptic conditions, the operation gives satisfactory results. The technic is identical with that employed in supravaginal amputation of the uterus, except that after the ligation of the uterine arteries the vaginal vault is cut through and the entire uterus removed, after which the opening in the vagina is closed with catgut and the broad ligament wounds are sutured. Total hysterectomy is rarely indicated except in cancer of the uterus, or in occasional cases of infection.

(*f*) *Portes' Operation.*—Reference has already been made to this operation, in which the uterus is allowed to undergo involution outside of the peritoneal cavity, and is later returned to it. I have had no experience with it, and imagine that its field of usefulness is limited. In most instances, in which it might be indicated, better results and a much shorter convalescence will follow supravaginal hysterectomy; but in the occasional case in which the patient is anxious to preserve the possibility of reproduction, and is willing to pay for it by a convalescence lasting many weeks, the results of Portes, and Phaneuf justify its employment.

In all forms of cesarean section, as well as in all other laparotomies, loose sponges should not be used after the peritoneal incision is made. From then on, only sponge holders should be employed, and care should be taken to see that they hold the sponges firmly. Furthermore, compresses or pads should be used only when they are sewed to a piece of tape to whose free end an artery clamp is attached. They should be counted at the beginning of the operation and before closing the peritoneal wound. Failure to observe these precautions will sooner or later result in a sponge or pad being left within the abdominal cavity, which is not only an uncomfortable accident for the patient, but may lead to serious medicolegal complications for the operator.

No matter what type of operation is to be performed, the choice of anesthesia is a matter of great importance. If a general anesthetic is employed, gas and ether give satisfactory results, but care should be taken to give as little ether as possible prior to the extraction of the child in order to prevent its being born in an apnœic condition.

Where the indication is afforded by a serious heart lesion, or when operation becomes necessary during the course of some respiratory affection, infiltration anesthesia by means of novocaine gives very satisfactory results. Indeed, DeLee and his associates employ it in most of their sections, no matter what the indication. The relatively high mortality following spinal anesthesia makes its employment somewhat dubious, except under special conditions. I advocate its employment in the rare instances in which section appears necessary in eclamptic patients, primarily to avoid the possible ill effects of general anesthesia upon the liver. Brindeau, who has a large experience in its use, states that it renders the operation almost bloodless as the result of the vigorous contraction of the uterus induced by it.

Choice of Operation.—When the operation is to be performed at an appointed time, or within six hours after the onset of labor upon patients who have not been exposed to the possibility of infection, the classical cesarean section is the operation of choice; whereas, if the operation is undertaken later or upon women who have been examined by those whose technic is open to suspicion, better results will be obtained by the low cervical technic. On the other hand, if the patient already presents signs of actual infection, as indicated by elevation of temperature, rapid pulse, and, possibly, a foul smelling vaginal discharge, many maternal lives will be saved by amputating the body of the uterus. Naturally, when the indication is afforded by myomata, which cannot readily be enucleated, the radical operation is also indicated, as well as in those cases in which osteomalacia is the cause of the pelvic deformity, or in which uncontrollable hemorrhage resulting from uterine atony complicates the intended classical operation.

In clean cases, it is a matter of personal choice whether one employs the classical or low cervical technic, although I prefer the former as being easier. For some time, I regarded as extravagant the claims made concerning the advantages of the latter, but after Hofbauer had demonstrated in our clinic the existence in the connective tissue about the margins of the uterus of a defensive mechanism against infection, I was compelled to assume a more favorable attitude, which has since been borne out by experience—with the result that in suspected cases I now do many fewer radical operations than formerly.

As will be indicated in the following section, the dangers of classical cesarean section increase with every hour the patient has been in labor. I showed one reason for it, in 1917, when I demonstrated histologically the presence of ascending infection in many uteri removed at radical section late in labor. In 1927, Harris and Brown adduced similar evidence by the bacteriological study of the uterine contents in fifty consecutive sections in our clinic. They found the uterus uniformly sterile in all elective sections, as well as in those performed within the first six hours after the onset of labor, whereas, bacteria were almost constantly present when the operation was done later, and in many instances they were streptococci.

Accordingly, our investigations show that equally good results should follow the classical or low technic when the uterus is sterile, but when it is infected that there is something about the latter technic which increases the resistance to infection. Whether this is due to the fact that the uterine incision is covered by peritoneum, or is in some way connected with the structure of the lower uterine segment, or with the existence of Hofbauer's protective mechanism, is not yet clear.

In doing a cesarean section, the question often arises as to the advisability of *sterilizing the patient* so as to avoid the possibility of future conception. I consider that it is best effected by supravaginal amputation of the uterus, with preservation of the tubes and ovaries, in order that the inconveniences attending a premature menopause may be avoided. This belief is based upon the fact that the uterus is useless if further pregnancies are out of the question, but more particularly because supravaginal amputation is safer and can be done more rapidly than the conservative operation followed by excision of the tubes. Furthermore, the convalescence following the former operation is more satisfactory, the difference being quite as marked as that observed in the treatment of uterine myomata by supravaginal amputation or by myomectomy, respectively.

It was formerly believed that sterilization could be effected by ligating the proximal end of either tube; but experience has shown that the ligatures eventually cut through or become absorbed, so that the lumen becomes reëstablished, and with it the possibility of future pregnancy. It was next suggested that the object might be accomplished by applying a double ligature to each tube and excising the portion between them; but the experiments of Fraenkel upon animals, and the experience of Zweifel, and Cripps and Williamson in women, have shown that even these measures do not insure against conception, since the ligatures may be absorbed and the cut ends of the tube become united. In order, therefore, to effect permanent sterilization by an operation upon the tubes, their proximal ends must be buried between folds of the broad ligaments, or they must be excised from the uterine cornua by wedge-shaped incisions and the wounds accurately closed by sutures.

Sterilization should not be attempted by the removal of the ovaries, for the reason that the retracting uterus may exert such tension upon the pedicles that the sutures may slip and fatal hemorrhage result, but more particularly because their internal secretion is necessary to the future well-being of the patient.

The opinion of those authorities who consider that sterilization should form an integral part of every cesarean section is certainly open to question. If the patient is intelligent, the decision should be left to her and her family, but at the same time the undesirability of a one-child marriage should be strongly urged; whereas with the ignorant it is incumbent upon the physician to do what he thinks is best under the circumstances. Personally, I am unwilling to sterilize any patient at the first operation, unless pathological conditions necessitate the removal of the uterus or its appendages, or unless the patient comes from a district where proper operative help might not be available in a future pregnancy. On the other hand, if she is weak-minded or diseased and is liable to become a public charge, the operation is justifiable. In general, with pauper patients, it is my practice to effect sterilization at the third section.

Cesarean section should never be performed solely for the purpose of sterilizing essentially normal women, as it leads to lax views concerning its indications. Each year, a number of women are sent me suffering from insanity, feeblemindedness, or other conditions, with the request that they be sterilized at the time of labor. Unless they present a definite indication for cesarean section, I decline to do it, but, instead, I allow spontaneous labor to occur, and some weeks afterwards sterilize the patient by the most appropriate procedure. By so doing, I feel that the mortality is reduced to a minimum, and at the same time, I keep my obstetrical conscience clear.

Prognosis.—When considering the history of cesarean section, reference was made to the mortality attending it in former times. Since the rehabilitation of the conservative operation by Sänger, in 1882, and the constant advance in aseptic technic, there has been a corresponding steady improvement in the results: Thus, Caruso reported a mortality of 25.56 per cent in 135 operations collected from the literature between the years 1882 and 1888. Since then the death rate has gradually fallen and many writers would have us believe that it is as low as one or two per cent. While this is correct for selected cases in the hands of experts, I imagine that it would be found to be in the neighborhood of 10 per cent if the actual results for the entire country could be ascertained.

That the mortality is generally underestimated is shown by the report of the committee on maternal and infant welfare of the Massachusetts Medical Society. This committee, in an attempt to ascertain why the mortality from childbirth was greater in 1920 than ten years previously, analyzed the deaths occurring in Massachusetts during the year 1921, and found that one-sixth of the entire number had followed cesarean section, one-half of these being due to infection. In other words, after frank puerperal septicemia, cesarean section constituted the second most common cause for death in childbirth in Massachusetts. One of the members of the Committee informed me that he was convinced that this excessive mortality was in great part due to the performance of the operation by surgeons who did not appreciate its dangers, and who operated upon patients at other than the optimum time.

Routh, in 1911, reported a mortality of 9.7 per cent in 1058 classical sections performed by 100 British operators; while Eardley Holland, ten years later, reported one of 4 per cent in a collective investigation based upon 4197 operations performed in 37 British hospitals.

In this country similar contrasts obtain. Thus, a committee of the New Orleans Gynecological Society reported a gross mortality of 16.1 per cent in 300 operations performed in eight hospitals between the years 1921 and 1927, while Gordon reported one of 7.25 per cent in 1805 operations done in 34 hospitals in Brooklyn during the same period. On the other hand, DeLee in 1928, presented the surprisingly low mortality of 1.2 per cent in a series of 718 operations.

It is apparent that the mortality must vary according to the indications for which the operation is performed. It should be relatively low when undertaken for pelvic dystocia or obstruction by tumor, and relatively high when eclampsia or severe accidental hemorrhage offer the indication. Generally speaking, the highest mortality occurs in eclamptic women, and was 40, 26 and 19.3 per cent, respectively, in the series of cases reported by the New Orleans Committee by Gordon, and by Miller; and it must be admitted that such results afford a potent argument against the employment of cesarean section in that disease.

Furthermore, no matter how good the operator, or how perfect his technic, it appears that the mortality, even in apparently uninfected women, will be low only when the operation is done at an appointed time before the onset of labor or within a few hours after the first pains, and that it will increase progressively with every additional hour of delay. Reynolds first appreciated this fact in 1907, and upon analyzing 289 operations, according as they were done before labor or early or late in labor, found a mortality of 1.2, 3.8 and 12 per cent, respectively. Routh and Holland arrived at almost identical conclusions, and the following table from Holland's article based upon 1953 sections for contracted pelvis, shows the striking effect of the time element:

Time of Operation	*Number of Cases*	*Mortality, Per Cent*
Before labor	1202	1.6
Early in labor	389	1.8
Late in labor	220	10.0
After induction of labor	35	14.0
After attempts at delivery by forceps, etc.	107	27.0
TOTAL	1953	4.3

My own experience is based upon more than 500 operations performed by myself or my assistants in the Woman's Clinic of the Johns Hopkins Hospital.

From January 1, 1920, to April 1, 1929, 349 operations were performed as follows:

Cases	*Gross Mortality, Per Cent*
255 conservative sections	1.77
56 low cervical sections	1.78
68 radical sections	10.3

In other words, there were 12 deaths in 349 operations—a gross mortality of 3.4 per cent. In 8 instances, however, death was not due to the operation, but rather to the condition which called for its performance. Thus, in 2 instances the indication was hemorrhage following rupture of the scar of a previous section; in 5 instances acute anemia associated with premature separation of the placenta—death occurring on the table or within twelve hours after the completion of the operation—and in one instance the patient was suffering from general peritonitis at the time of admission; upon deducting these, 4 deaths are left—a net mortality of 1.17 per cent, with only a single death (0.29 per cent) due to infection.

This stands in marked contrast to the mortality of 12 per cent in our first fifty sections, and is due to the fact that in the first series we had not appreciated the dangers inherent to classical sections done late in labor; whereas in the present series classical section was done only at an appointed time or within the first six hours following the onset of labor, while in all others we resorted to the low cervical or radical operation.

As has already been indicated, my investigations, as well as those of Harris and Brown, show that the difference is due to ascending infection, and that this begins within six hours after the onset of labor, even in women who have not been examined vaginally and who present no clinical signs of infection. Whether this is due to the entrance into the uterus of bacteria primarily present in the vagina, or to the wandering up of bacteria along the capillary layers of fluid extending from the external genitalia is not yet clear. Whatever the source of the bacteria, it would appear that the incised body of the involuting uterus facilitates their extension; whereas the low cervical operation in some way offers a more effective resistance.

My own experience shows that one can reckon upon a mortality of between 1 and 2 per cent following the classical or low cervical operation only when it is done at an appointed time at the end of pregnancy or within the first six hours following the onset of labor, and that with the former results become rapidly worse the longer the operation is deferred, whereas with the latter the increase in mortality occurs more slowly. It should be constantly remembered that ideal results only follow when the indication for interference is afforded by labor obstructed by contracted pelvis, by tumors or by similar conditions, and cannot be expected if many operations for eclampsia or severe cases of premature separation of the placenta are included in the series. Finally, it should constantly be borne in mind that the only successful means of coping with actual infection is by means of the radical section or possibly by Portes' exteriorization operation.

The mortality following the Porro, or radical section, has shown an improvement corresponding to that following classical section. Thus, R. T. Harris, upon analyzing the results in a series of 441 such operations, showed that the mortality of 60 per cent, in 1876, had decreased to 22.8 per cent, in 1891. Following the introduction of modern methods for supravaginal amputation of the uterus, with retroperitoneal treatment of the stump, still further improvement followed, so that now the mortality has fallen almost unbelievably, and in clean cases is often as low as the classical operation. J. W. Harris reported the results which we had obtained in 64 radical sections up to 1922. Since then, the number has increased to 126 (April 1, 1930), with a gross mortality of 8 per cent, with only a single death from infection. Furthermore, it should be remembered that in 40 of these cases the existence of actual infection was the determining factor in the decision to resort to the radical procedure.

Repeated Cesarean Section.—The performance of conservative cesarean section does not interfere with future conception, as is shown by the fact that even in preantiseptic times not a few instances were reported in which the same woman had repeatedly been subjected to the operation. Nor does it necessarily affect recovery at a subsequent operation. I have several times done four successive cesarean sections upon the same patient, and Ahlfeld, Birnbaum and others have reported cases of women who underwent five sections. With the increased employment of the operation, repeated cesarean sections are frequently necessary. Among 349 sections performed in our service from January, 1920, to April, 1929, 106 were repeaters, who were divided as follows: 74 second, 29 third, and 3 fourth sections; while as early as 1906 Frühinsholz was able to collect 52 instances in which the operation had been performed for a third time upon the same patient.

The occurrence of pregnancy after a classical cesarean section is not devoid of danger, as the recent literature indicates that rupture occurs through site of the previous incision in from 1 to 4 per cent of the subsequent gestations, and certain authors consider it so real a danger that they have laid down the dictum, "Once a cesarean, always a cesarean." This is an exaggeration, and is in part based upon the belief that the uterine incision heals by the formation of scar tissue—whence the term cicatrix—and that the newly found connective tissue stretches and sometimes yields when the uterus becomes distended. That such a belief is erroneous is shown in three ways. First, inspection of the unopened uterus at the time of repeated sections usually shows no trace of the former incision, or, if present, it appears as an almost invisible linear scar. Second, when the body of the uterus has been amputated, no scar is visible after hardening, or at most a shallow vertical furrow is present upon the external and internal surfaces of the anterior uterine wall, while between them no trace of scar tissue is apparent. Third, and most important, histological examination

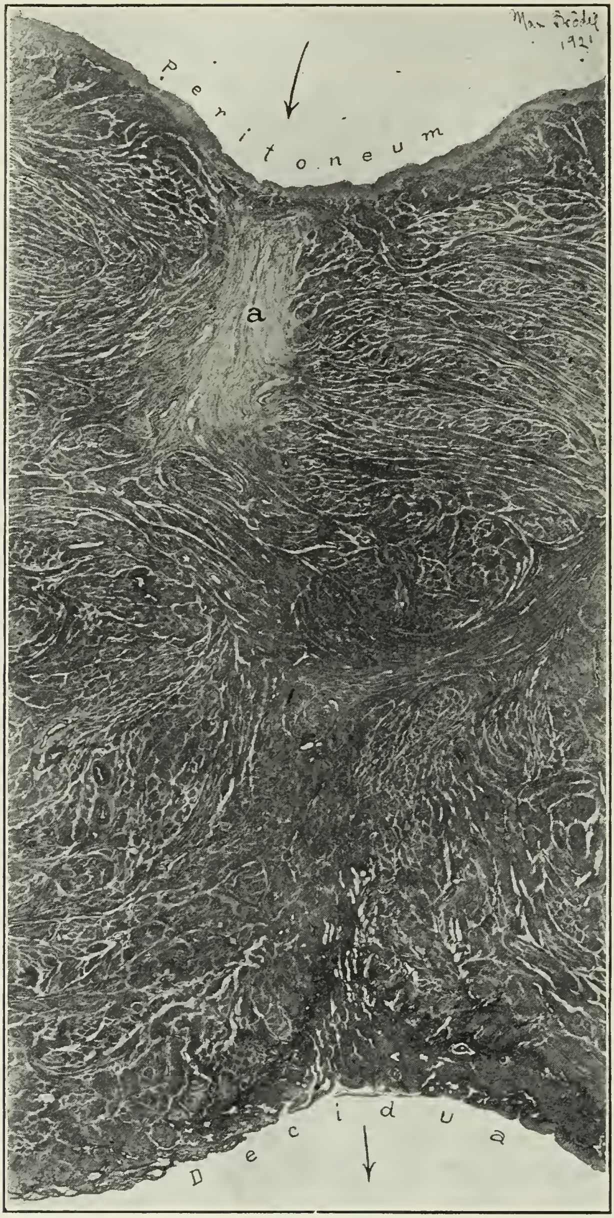

Fig. 459.—Section through Site of Previous Cesarean Section, Showing Interlacing Muscle and Absence of Scar Tissue.

of the site of the incision shows that the uterus, just as all other organs made up of nonstriated muscle, heals by regeneration of the muscle fibers and not by scar tissue. Figure 459, which represents a microscopic section through the site of the previous incision in a uterus removed at a second cesarean section, shows the furrows above referred to and demonstrates that the tissue between them is made up of muscle fibers which interlace in such a way as to give no evidence of ever having been injured.

Even when the healing has been so imperfect that marked thinning has resulted, the tissue which remains is almost entirely muscular in character. Consequently, I believe when the incision has been properly sutured that the risk of subsequent rupture is minimal, provided infection has not occurred. That rupture, nevertheless, sometimes occurs is shown by the fact that Holland, in 1920, was able to collect 97 such cases, and since then many additional ruptures save been reported. I have seen several, but only in a single patient whose original section had been done on our service. In this instance, the incision had broken down following the first section, so that a utero-abdominal fistula resulted for a time.

It is contended by enthusiastic advocates of low cervical section that rupture of the scar is less apt to follow it than the classical operation. The article of DeLee, Nadelhofer and Greenhill, however, does not appear to bear out the contention, as on several occasions in 91 repeated sections following laparotrachelotomy they found the old incision just on the point of rupturing. They also report that the scar was excised and studied microscopically in 31 cases, and that in 26 instances it consisted of connective tissue. Should this prove to be the general rule, it would not argue in favor of the operation, as a connective-tissue scar would be more liable to rupture than the muscular union which occurs after the classical section.

The possible occurrence of rupture should always be considered in connection with the employment of cesarean section for other than pelvic indications, as thereafter the uterus must be considered as a "locus minoris resistentiæ." In such cases a normal spontaneous termination should be anticipated in subsequent labors, unless the puerperium had been febrile, but it is nevertheless advisable for the patient to be under observation in a hospital so that immediate laparotomy can be undertaken should rupture occur.

K. M. Wilson, in 1926, studied a series of 133 women delivered on our service after a primary section. As most of them were done for a pelvic indication many repeated sections were necessary, but nevertheless 42 of the pregnancies were completed through the natural passages, 3 ending in abortion and 39 in spontaneous labor.

It is also stated that the adhesions which frequently form between the uterus and the anterior uterine wall, as well as with the omentum and occasionally with the intestines, sometimes exert a deleterious influence in subsequent pregnancies. Aside, however, from the discomfort incident to their stretching, no serious consequences follow, although at subsequent operations they may seriously complicate the operative technic. In earlier days, the formation of dense adhesions was considered advantageous, as they were sometimes so extensive that subsequent sections could be done without opening into the general peritoneal cavity. At present, however, they are no longer so considered, as it is necessary to get rid of them in order to secure ideal closure of the new incision.

Vaginal cesarean section has already been considered in the chapter upon Accouchement Forcé.

Postmortem Cesarean Section.—From the earliest times, when a patient died undelivered in the neighborhood of full term, cesarean section was sometimes performed immediately after the death, in the hope of saving the life of the child. The number of children rescued by the procedure, however, has always been very small. In view of this fact, and the abhorrence in which it is more or less justly held by the laity, I should not recommend it, and should resort to it only at the urgent request of the patient's family.

SYMPHYSEOTOMY

By symphyseotomy is meant the division of the pubic joint in order to bring about an increase in the capacity of a contracted pelvis sufficient to permit the passage of a living child.

J. R. Sigault first performed the operation in 1777, and thereby successfully delivered a certain Madame Suchot, of Paris, who had a rhachitic pelvis with a conjugata vera of 6.5 centimeters and had previously given birth to four dead children. The procedure created a great sensation, though when the patient was exhibited before the Faculty of Medicine two months later she walked with considerable difficulty, and had a urinary fistula from which she never recovered.

The operation was taken up with great enthusiasm, and was performed upon 11 patients within the year following Sigault's report. Opposition to it, however, soon developed, Baudelocque denouncing it as a "murderous and unphilosophical procedure"; and the discussion as to its merits waxed so bitter that the Parisian physicians became divided into two groups, cesareans and symphyseans. As a result of poor technic and its employment in unsuitable cases, symphyseotomy soon fell into disrepute and was forgotten except in Italy, where it was performed sporadically until the year 1858.

The operation was rehabilitated in 1866 by Morisani, of Naples, who obtained fairly satisfactory results by its means, being able to report 50 operations with 40 recoveries to the International Medical Congress in 1881. It was reintroduced into France by Spinelli, in 1891, who impressed its merits so strongly upon Pinard that he became its most enthusiastic advocate, being able to report in 1900 that 100 symphyseotomies had been performed in his clinic. The anatomical aspects of symphyseotomy were carefully studied by Farabeuf, who accurately demonstrated its theoretical possibilities. Robert P. Harris played a prominent part in directing attention to the operation in this country by a paper entitled "The Remarkable Results of Antiseptic Symphyseotomy," read at the 1892 meeting of the American Gynecological Society. Stimulated by this report, Jewett, a few months later, performed the first operation in America, and was soon followed by many others. Symphyseotomy was the main theme of discussion at the German Gynecological Congress in 1893, the International Medical Congress in 1897, and the Obstetrical Society of France in 1899, but in recent years it has practically been abandoned in favor of pubiotomy.

As soon as the symphysis is cut through, the ends of the pubic bones gape from 3 to 6 centimeters. Owing to the structure of the sacro-iliac joints, the ossa innominata flare outward, while the tips of the pubic bones become depressed downward. As a result of these changes the capacity of the pelvic canal becomes considerably increased, particularly in its transverse and oblique, and less so in its anteroposterior, diameters. It is usually stated that the conjugata vera becomes 2 millimeters longer for each centimeter of separation at the symphysis. As the latter may amount to 6 or 6.5 centimeters without imperiling the integrity of the sacro-iliac joints, the increase would aggregate 12 or 13 millimeters.

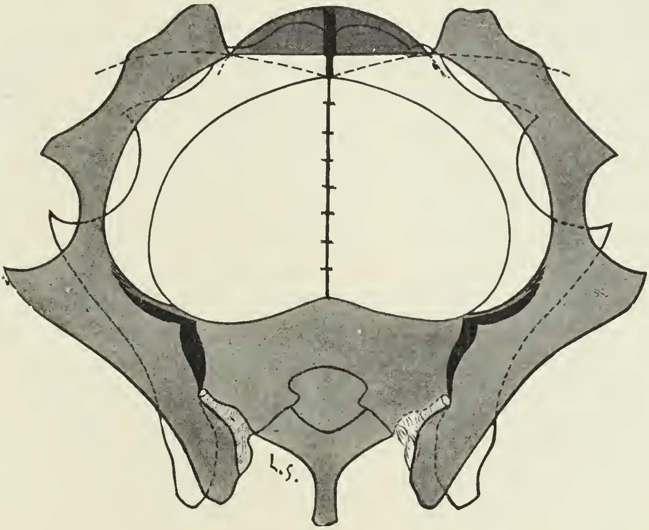

Fig. 460.—Diagram Showing Effect of Symphyseotomy (Farabeuf).

According to Farabeuf this estimate is not strictly correct, as the increase varies with the size of the pelvis, being 13 millimeters when the true conjugate measures 6 centimeters, and 10 millimeters when it measures 9 centimeters. This, however, does not represent the actual enlargement of the superior strait from an obstetrical point of view; for, as Farabeuf has pointed out, one of the parietal bosses fits into the opening between the gaping pubic bones, thereby considerably increasing the space available for the passage of the head. Döderlein has calculated that when the pubic bones gape 6 to 7 centimeters the area of the superior strait is increased by one half.

As the results following symphyseotomy by the open method eventually proved disappointing, and as those following cesarean section were constantly improving, the operation again fell into desuetude and is now rarely resorted to, except by a few operators who employ a subcutaneous technic, such as Zweifel, Frank, and Schwartz, the latter having reported 113 cases with only three maternal deaths. For these reasons the indications and technic of the operation will not be considered, more particularly as what will be said in the following section concerning pubiotomy will apply to subcutaneous symphyseotomy as well.

PUBIOTOMY

This operation, which is more property designated as hebotomy or hebosteotomy (from *τὸ τῆς ἥβος ὀσσοηῦν*), consists in obtaining a temporary enlargement of the pelvis by severing the pubic bone to one side of the symphysis by means of a Gigli saw.

History.—In 1893, Gigli stated that from a surgical point of view there were two serious fallacies in the operation of symphyseotomy. In the first place, the wound through the cartilage was very prone to infection, and healed but slowly, and, secondly, the incision in the midline deprived the urethra and bladder of their natural support, and thus exposed them to serious injury during the delivery of the child. To overcome these difficulties, he proposed that the incision be made through the pubic bone itself, as he held that the bone wound would heal more rapidly and be less liable to infection, while its lateral position would avoid interference with the attachments of the urethra and bladder, and thus reduce to a minimum the possibility of their injury. In order to sever the bone he invented the flexible wire saw, which is known by his name.

Gigli did not perform the operation until April, 1902, but his suggestion was put into practice by Bonard, of Lugano, in 1897, who was followed by Calderini and Van der Velde, in 1899 and 1901, respectively. Following the report of the latter, the operation was rapidly taken up and modified, so that three methods are now available.

Technic.—Originally, the anterior surface of the bone was exposed by an oblique incision, beginning slightly above the inner margin of the pubic spine and extending to the middle of the outer part of the labium majus. Then by means of a pair of artery forceps the saw was adjusted to the posterior surface of the bone, which was then severed. In 1904, Döderlein modified the operation and instead of a large open wound, made a small incision, just large enough to admit a finger, parallel to and somewhat above the pubic bones. After separating the periosteum, a curved instrument, somewhat like a large aneurism needle, was passed behind the bone and pushed through the labium majus. The saw was then fastened to the projection at the lower end of the instrument, and brought into position by withdrawing it. In 1906, Stoeckel and Kannegiesser reported that their respective chiefs, Bumm and Leopold, had performed the operation entirely subcutaneously. For this purpose the instrument was thrust through the upper end of the labium majus, and, under the guidance of a finger in the vagina, carried up along the posterior surface of the pubic bone and brought out through the skin above its upper margin, between the pubic spine and the symphysis pubis, the saw being adjusted by withdrawing the instrument from above downward.

Up to April, 1915, my assistants or myself had performed 43 consecutive successful pubiotomies upon 40 patients, three women having been operated upon twice. As Döderlein's method was employed in all but the first case, and has proved very satisfactory, I shall describe its technic in some detail.

After emptying the bladder and rectum and shaving the lower abdomen and pubic region, the patient is brought to the edge of the table, and prepared for operation in the usual manner. The legs are held by assistants. An incision extending 2.5 centimeters inward from the pubic spine is then made just above the upper margin of the pubic bone, and the tissues cut through down to it. After incising the periosteum, a finger is passed into the wound and separates the tissues from the posterior surface of the bone. Then a Döderlein needle is carried down along the posterior surface of the bone, and when its inferior margin is reached the handle of the needle is rotated in such a manner that its tip is felt through the upper and outer part of the labium majus. A small incision is made over the projection, through which the tip of the instrument is pushed. To it one end of the saw is attached, and is drawn into position as the instrument is withdrawn through the upper wound. The handles are then attached to the saw and a few moments suffice to sever the bone. Care should be taken that the section is made in the desired direction, and that the movements are continued until the saw moves freely beneath the skin.

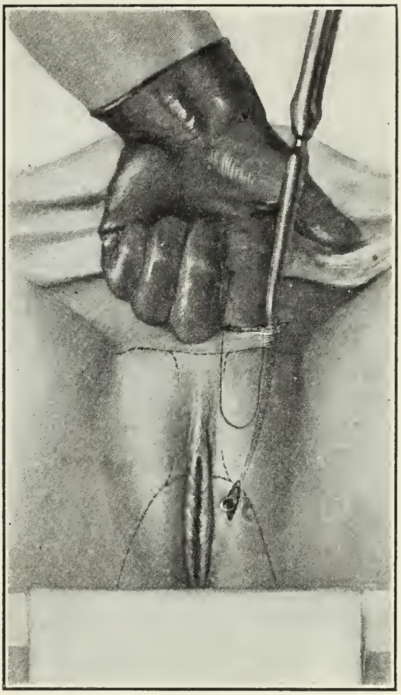

Fig. 451.—Showing Incisions for Pubiotomy.

In many cases the ends of the bone gape for 2 or 3 centimeters as soon as the section is complete; but, if all the ligamentary structures have not been divided, this does not occur until traction is made upon the child. Upon withdrawing the saw, blood gushes freely from both wounds, but in all of my cases the hemorrhage was readily controlled by firm pressure with gauze sponges. As soon as it is checked, the child should be delivered by forceps or version, as is most convenient, as I can see no advantage in waiting for its spontaneous expulsion, as recommended by certain German writers. As traction is made, the ends of bone will gape more widely, but a separation of more than 5 or 6 centimeters should be avoided by having the assistants make firm pressure upon the thighs. While waiting for separation of the placenta, a small gauze drain should be brought through the opening in the labium majus, and the upper wound is sutured.

After labor the patient is cleaned up, a sterile dressing is applied over the upper wound, and a long strip of adhesive plaster six inches wide is then passed around the entire body so as to make firm and equal pressure over the trochanters. This is not essential, as many German operators do not attempt to immobilize the pelvis. The patient is then put to bed, and, for convenience in handling, placed upon a Bradford frame, upon which she begins to move freely on the second or third day. She is not catheterized unless necessary, and is kept in bed for fourteen days, but is allowed to sit up as soon as she desires. She is encouraged to try to walk on the second day after getting up. The power of locomotion soon returns, and all of my patients have felt able to leave the hospital before the end of the fourth week.

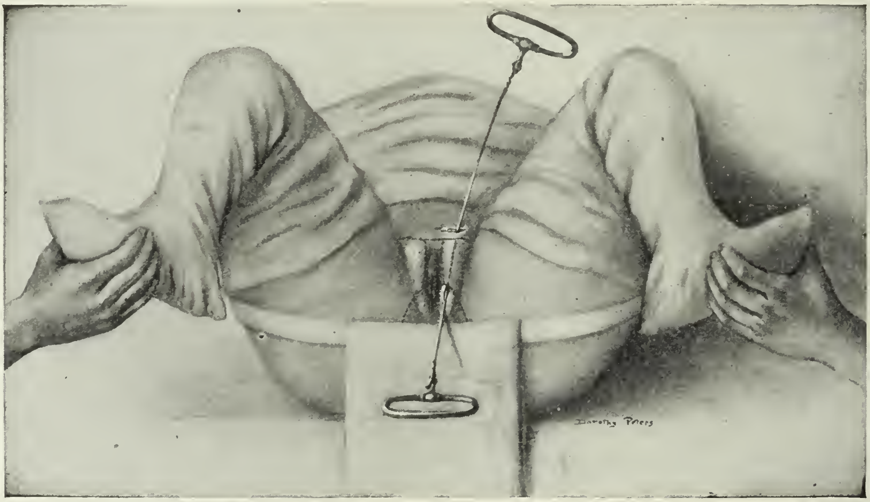

Fig. 462.—Showing Position of Patient and Gigli Saw.

I have had no experience with the purely subcutaneous operation, but Roemer states that it is followed by injuries to the bladder twice as frequently as when Döderlein's technic is employed, so that it would seem that the possibility of injuring the bladder is somewhat lessened by separating the tissues posterior to the bone with the fingers.

Healing of the bone wound usually occurs by fibrous union, which was noted after all of our operations. This, however, has no effect upon locomotion, as all of my patients, upon reëxamination months or years later, stated that they were able to walk as well and work as hard as previously. Moreover, the occurrence of fibrous union should be regarded as a favorable outcome, for the reason that it sometimes leads to a definite enlargement of the pelvic diameters, which may be still further accentuated in a subsequent pregnancy by the softening and relaxation incident to the increased hyperemia attending that condition. In 1915, I reported that 20 of my pubiotomy patients had subsequently given birth to 30 children. Ten of them had 12 spontaneous labors at term; in the others operative interference was again necessary. It therefore appeared that there is an almost even chance of the pelvis becoming definitely enlarged as the result of pubiotomy, and careful pelvic mensuration showed the correctness of the supposition; as the conjugata vera was found to be lengthened in 6 and the transverse diameter of the outlet in 11 instances. In the former, the increase was but slight, and only in two cases did it amount to as much as 1 centimeter; whereas in the latter the increase was considerable, varying between 1 and 3 centimeters, and averaging 1.8 centimeter. These observations indicate that considerable permanent enlargement of the pelvis is not to be expected when the contraction involves the superior strait; whereas, in funnel pelves, it is often sufficient to convert the contracted outlet into a normal one, and thus permit subsequent spontaneous labors.

Prognosis.—Schläfli, in 1909, collected 700 operations from the literature with a mortality of 4.82 per cent. I consider that these figures give an exaggerated idea of the dangers of the operation, as they are based upon the results of 142 operators, many of whom had little experience, and naturally could not be expected to obtain the best results. On the other hand, Kupferberg, in 1927, recorded a maternal mortality of 1.9 per cent in 151 operations performed with Frank's subcutaneous technic, and my own experience has indicated that it should not be greater. Such results are comparable to those following early conservative cesarean section, and are far superior to those obtained when it is performed after a test of the second stage of labor.

Usually the hemorrhage, which may be quite profuse, is venous in character, and is readily controlled by pressure; but occasionally aberrant branches of the internal pudic artery may be cut, when it may become necessary to lay the entire wound open to ligate the bleeding vessel. Very exceptionally, even this is not possible, and one of Rosthorn's patients died from uncontrollable hemorrhage.

Moreover, deep vaginal tears frequently occur during the extraction of the child, and require immediate repair; while less often the bladder or urethra is injured, either by being perforated by the sharp ends of the bone, or as the result of traction. If proper care is taken in dilating the birth canal with the hand before beginning the operation, by making horizontal instead of upward traction when delivering the head, and by avoiding undue violence, the occurrence of such accidents can be minimized. In only one of my cases was the bladder injured; in a number the vagina was torn, but in each instance satisfactory healing resulted after primary repair. Strange to say, the perineum is rarely torn.

Convalescence in general is very satisfactory, and the patients complain of but little pain or discomfort. In nearly one half of the cases the puerperium is slightly febrile, but only one of my patients was seriously ill. In many instances there is considerable edema about the vulva and occasionally hematomata of considerable size develop. Moreover, several writers believe that the operation considerably increases the liability to femoral phlebitis.

Indications.—Pubiotomy is performed solely in the interests of the child. and is contra-indicated when it is dead or in poor condition, or when the conjugata vera measures 7 centimeters or less. Furthermore, even in pelves above this limit, it is never indicated as a primary operation. For this reason, it should not be performed in patients presenting disproportion between the size of the head and the pelvis, who are seen before the onset of labor or within a few hours thereafter, as in them elective cesarean section is the operation of choice. On the other hand, if the patient is not seen until late in labor, pubiotomy will give better results than a late classical section.

In my experience, the chief indication for the operation was formerly presented by patients in whom the disproportion appears to be so slight that spontaneous delivery is anticipated, but in whom the test of several hours of second stage pains demonstrates that the head cannot be forced through the superior strait. In such circumstances the mortality following classical cesarean. section is in the neighborhood of 10 per cent, while that of pubiotomy is 1 per cent, and consequently, there was formerly no difficulty in determining which operation was indicated. Now, however, since low cervical section gives equally good results, I feel that few will elect pubiotomy in the treatment of dystocia due to contraction of the pelvic inlet, although Bill, of Cleveland, holds that it still has a restricted, but definite field of usefulness.

In view of the permanent widening of the pelvic outlet to which reference has already been made, I consider that the real indication for pubiotomy is afforded by pronounced grades of funnel pelvis; as in them the operation will not only permit the delivery of the child, but quite probably will lead to such permanent enlargement of the outlet that spontaneous labor will be possible in the future. In such circumstances, pubiotomy is preferable to elective cesarean section, except in really elderly primiparæ, in whom no chances can be taken with the prospects of securing a living child. I cannot, however, endorse the suggestion of Jellett, who proposes that pubiotomy be done in nonpregnant women as a prophylactic measure, in the expectation that it will radically cure the pelvic deformity.

Pubiotomy may also be indicated in face presentations when the chin has rotated into the hollow of the sacrum. Furthermore in certain cases of breech or transverse presentation associated with moderate degrees of pelvic contraction, laying the Gigli saw prophylactically before beginning extraction adds greatly to one's equanimity, as it enables one to saw through the pubic bone as soon as serious resistance develops, and thus save the life of the child which otherwise would be lost. In many such cases, pubiotomy is not necessary, but the knowledge that it can be resorted to immediately adds greatly to the operator's feeling of security.

I do not believe that pubiotomy should be undertaken when signs of infection are present, as the interests of the mother will be better served by craniotomy or cesarean section followed by the removal of the uterus. Likewise, I feel that pubiotomy should not be done except in well-equipped hospitals or in the practice of experts, since several well-trained assistants are necessary to its proper performance, and, moreover, serious complications may occur at any time, which will seriously tax the resources of even a competent surgeon.

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CHAPTER XXIII

DESTRUCTIVE OPERATIONS

CRANIOTOMY

Under this heading are included all operations which bring about a decrease in the size of the fœtal head, with a view to rendering its delivery easier.

Prior to the introduction of podalic version and forceps, artificial delivery could be effected only by means of craniotomy or embryotomy, one or other of which was resorted to in nearly every case of difficult labor. Accordingly, in former times, the perforator, sharp hook, and crotchet were the most important instruments in the obstetrician's armamentarium. Increased dexterity in the employment of forceps and version, however, brought about a rapid change, and now, as the result of the relatively low mortality from cesarean section, many obstetricians hold that craniotomy upon the living child is not justifiable in any circumstances.

Indications.—Craniotomy is positively contra-indicated when the conjugata vera measures less than 5.5 centimeters, since in such cases the extraction of the child, even after the skull has been crushed, is attended by a greater maternal mortality than cesarean section late in labor. On the other hand, in pelves above this limit, while craniotomy may be indicated whenever the delivery of a mutilated child is the most conservative procedure so far as the safety of the mother is concerned, its employment should be restricted to the greatest possible extent.

The indications for its performance vary markedly. When the child is dead craniotomy is always indicated, unless the disproportion between the head and the pelvis is so slight that delivery by forceps or version can be accomplished without detriment to the mother. Esthetic considerations should never deter the operator from resorting to it. On the other hand, if the child is alive, the operation is justifiable only in very exceptional cases; indeed, many authorities go so far as to hold that it should never be performed. This, however, must be looked upon as too radical a view; for, although it must ever be the duty of the obstetrician to do his best to save the life of both mother and child, it is nevertheless conceivable that conditions may arise under which craniotomy upon the living child may not only be justifiable, but even imperatively demanded.

Generally speaking, craniotomy should not be performed upon the living child if the mother is in good condition, amid suitable surroundings, and in the hands of a competent operator. In such circumstances, if the obstacle to labor be due to a contracted pelvis or a large child, low cervical cesarean section is preferable, inasmuch as the slightly greater risk to the mother is more than compensated for by the rescue of her offspring. On the other hand, if the woman is not seen until she has been in the second stage of labor for a considerable time, and is already infected, any type of cesarean section, except the radical, is clearly contra-indicated. In such circumstances in primiparous women the child should be sacrificed in the interests of the mother, as the only safe alternative consists in cesarean section followed by hysterectomy, which inevitably entails complete abolition of the reproductive function. Again, if the child is in poor condition, as shown by a too rapid or too slow heartbeat, or by the passage of considerable quantities of meconium with a vertex presentation, its life is already in such peril that, against that of the mother, it is no longer entitled to serious consideration.

Moreover, in isolated districts, where the physician is unable to summon sufficient assistance, and is without the necessary appliances for an aseptic operation, cesarean section or pubiotomy should not be undertaken, and craniotomy becomes the operation of choice. But even under these adverse conditions, the destructive operations should be deferred as long as possible, and should not be resorted to until delivery becomes imperative in the interests of the mother, and then only after the failure of tentative attempts at forceps delivery. If, however, the patient should again become pregnant, she should be sent to a city where expert treatment can be obtained, as I consider that a physician who repeatedly performs craniotomy upon the same patient is little better than an abortionist.

Hydrocephalus affords a positive indication for craniotomy, which should be performed as soon as the cervix is completely dilated. In many instances extraction will not be necessary, as the mere evacuation of the fluid may be followed by the spontaneous extrusion of the child. In this condition a destructive operation is the more readily undertaken, as even a successful cesarean section will only give us a child that is doomed to die shortly or to remain an idiot.

When insuperable obstacles are encountered during the extraction of the after-coming head, craniotomy is a justifiable procedure, since the child is already dead, or dies within a few minutes after the nature of the obstacle has been recognized, and before preparations can be made for its delivery by pubiotomy.

Craniotomy should not be performed upon the mature child until the external os has become completely dilated, as the imperfectly opened canal may offer a serious obstacle to its extraction. On the other hand, this caution does not apply when the child is immature, as in such conditions craniotomy affords a satisfactory means of delivery through a partially dilated cervix.

Operative Technic.—The patient should be placed in the lithotomy position, and prepared as for other obstetrical operations. Craniotomy usually includes two steps: First, the perforation of the head and evacuation of its contents; and, secondly, the extraction of the mutilated child.

Numerous instruments have been devised for perforating the head, the most suitable of which is *Smellie's scissors* or Blot's perforator. Braun's trepan would serve the purpose admirably, but is not to be recommended on account of the difficulty with which it is kept clean.

If the head is engaged and firmly fixed, perforation is accomplished with but little difficulty. With two fingers the large or small fontanel, as may be most convenient, is located, and the perforator plunged through it. The opening is then enlarged and the instrument briskly moved about within the skull so as to destroy the central ganglia, and to disintegrate the brain to such an extent that it can be washed out with a douche of sterile water.

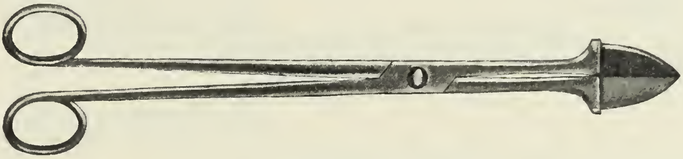

FIG. 463.—SMELLIE'S SCISSORS.

If, however, the head is movable above the superior strait, it must be firmly fixed by means of pressure exerted by an assistant through the abdominal walls. To avoid wounding the maternal soft parts, it is advisable to perforate the portion of the head which lies in the neighborhood of the symphysis pubis; for, should the instrument slip from this position, it is less liable to inflict serious injury than if it were near the sacrum. In face presentations perforation should be effected through the frontal suture.

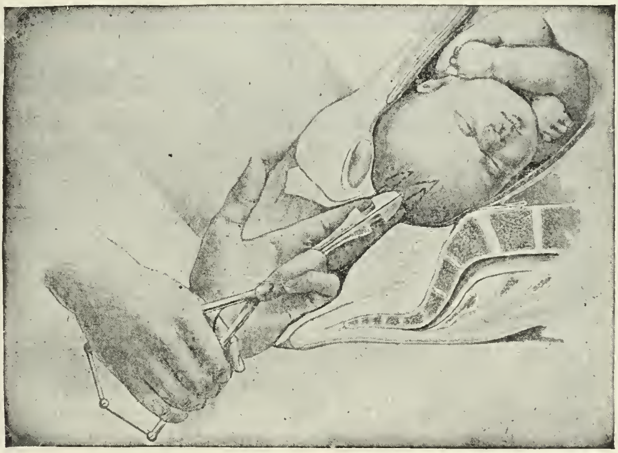

FIG. 464.—METHOD OF PERFORATING HEAD (American Textbook).

To pierce the after-coming head, the body of the child should be depressed, and the instrument carried into the skull in the neighborhood of the temporal suture. If, as occasionally happens, this point cannot be reached, the body of the child should be carried up over the abdomen of the mother, and perforation effected through the mouth and base of the skull. When a hydrocephalic child presents by the breech, and the head is arrested at the pelvic brim, the fluid contents of the skull may be evacuated by cutting through the arch of one of the cervical vertebræ, after which a metallic catheter is passed through the opening and carried along the vertebral canal into the skull.

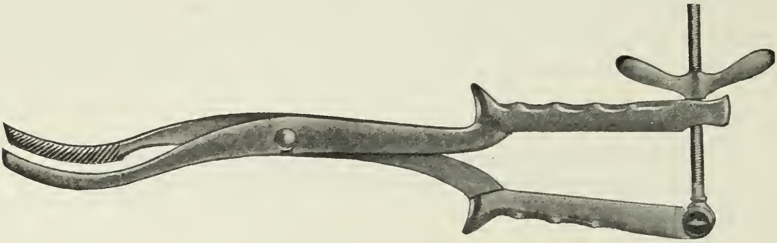

Fig. 465.—Simpson-Braun Cranioclast.

After the brain has been washed out, the collapsed head may be expelled by the uterine contractions alone, or may be extracted by means of the forceps or a finger introduced through the perforation opening. But even in moderate degrees of pelvic contraction it is usually advisable to make use of a special instrument for grasping and crushing the base of the skull. The *cranioclast,* invented by Simpson and modified by Carl Braun, serves the purpose most satisfactorily. Its solid blade is introduced through the perforation until its free end impinges upon the base of the skull, while the fenestrated blade is applied over the face or lower portion of the occiput. The vise at the end of the instrument is then tightened, and as a result not only is the base of the skull more or less compressed, but at the same time a firm hold is obtained for the extraction that is to follow.

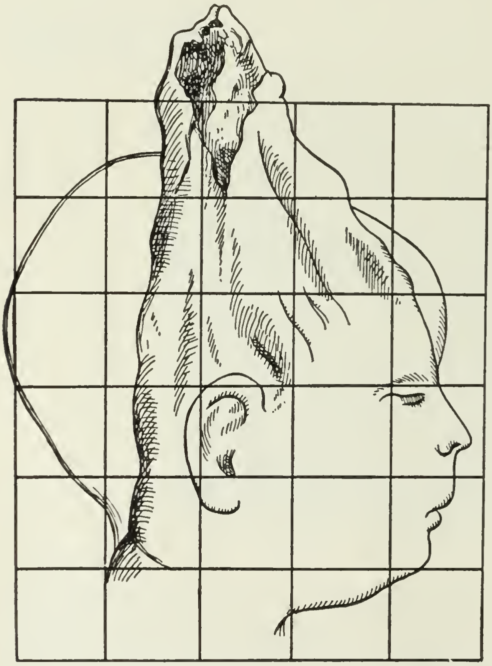

Fig. 466.—Head Crushed by Cranioclast (Simpson).

Although the vault of the cranium collapses after craniotomy and the washing out of its contents, the base of the skull still remains unchanged and, as the bimastoid diameter measures between 7 and 7.5 centimeters, it is obvious that delivery cannot be effected through a pelvis presenting smaller measurements until the base of the skull has likewise been crushed. For this purpose many instruments have been devised, and formerly the cephalotribe, invented by Baudelocque the younger, was extensively employed. This is essentially a very heavy forceps, whose blades come closely together and forcibly compress the head, when the vise at the ends of the handles is tightened. The instrument has been subjected to many modifications, the best being those of Tarnier and Braxton Hicks. At the same time it labors under the disadvantage that it aims to accomplish two purposes—*i. e.*, crushing and extracting the head; and, unfortunately, whenever it is so constructed as to be an efficient crusher it is a poor tractor, and *vice versa*. For these reasons the cephalotribe, as such, is but little used.

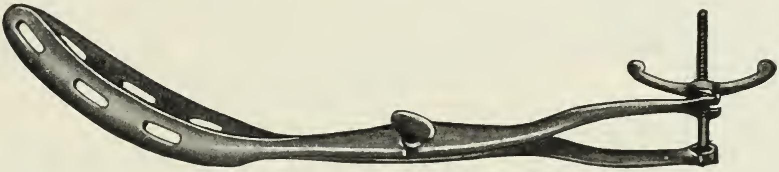
Fig. 467.—Tarnier's Cephalotribe.

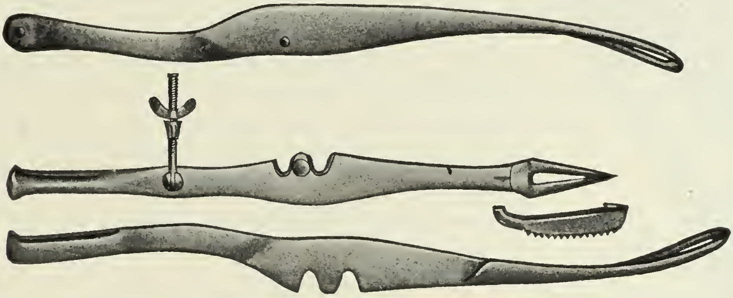
Fig. 468.—Tarnier's Basiotribe, Disarticulated.

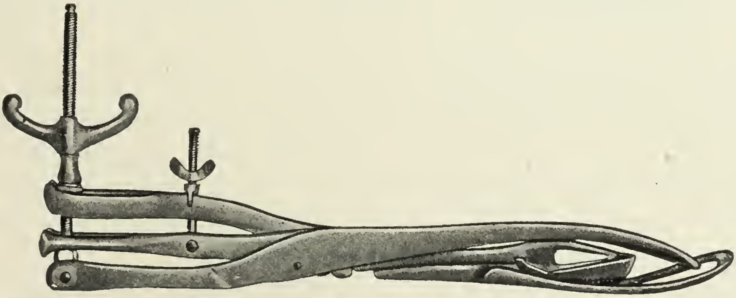
Fig. 469.—Tarnier's Basiotribe.

Tarnier, in 1883, invented the *basiotribe*, a three-bladed instrument which combines in one the advantages of the perforator, cranioclast, and cephalotribe. One blade is spear-pointed, and after serving as a perforator is forced into the base of the skull. The second blade is then introduced over the occiput and the third over the face of the child. All three are articulated, and the vise at the handles is screwed down, with the result that the base of the skull is fractured in many directions, and the head is compressed into an elongated and shapeless mass. This is a most efficient instrument, and has been particularly recommended by Pinard and Bar.

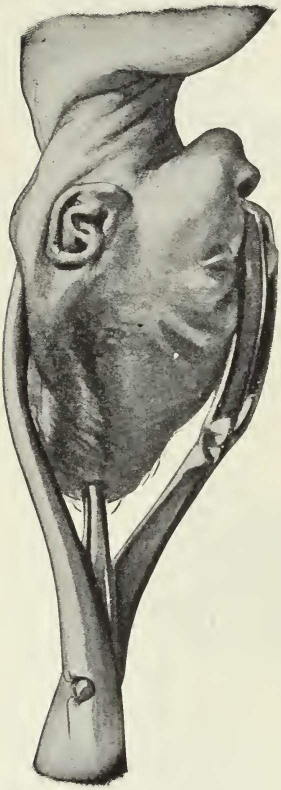

Fig. 470.—Effect of Basiotribe.

Sir A. R. Simpson, of Edinburgh, devised an instrument known as the *basilyst tractor,* which likewise consists of three blades. The tips of two of them come together and form a screwlike instrument. This first perforates the skull, and by a rotary motion is then worked into the base, which is fractured in many directions by separating the two blades by pressure upon the handles. After this the third blade is introduced over the face or occiput and screwed tightly in place, thus converting the instrument into a typical cranioclast (Figs. 471 and 472). According to its inventor, the basilyst tractor will compress the base of the skull into a mass 3.5 centimeters in diameter.

When perforating a hydrocephalic child, it is important to remember that the brain is spread out over the interior of the skull as a layer of tissue which may be only a few millimeters thick. When this is perforated, the fluid filling the dilated ventricles of the brain escapes and the skull collapses, after which delivery is readily effected. Unless especial precautions are taken, mere perforation occasionally does not result in the death of the child, which will cry after its birth. In order to guard against this distressing occurrence, the obstetrician should not be content with merely perforating the skull at one point, but should carry the instrument back to the base of the brain and stir it around so as to destroy effectually the upper portion of the medulla. Pernice reported the case of an infant who survived craniotomy and grew up an idiot.

Prognosis.—In moderate degrees of pelvic contraction, craniotomy, if properly performed in uninfected women, is almost devoid of danger. On the other hand, when the conjugata vera measures 5.5 centimeters or less, the mortality becomes considerable. Moreover, it must be remembered that if the operation be deferred until infection has occurred, and the patient has become profoundly exhausted, its mortality approximates that of late cesarean section.

EMBRYOTOMY

In embryotomy the viscera are removed through an opening in the thorax or abdomen of the child, or the head is severed from the body. The former operation is known as evisceration, the latter as decapitation.

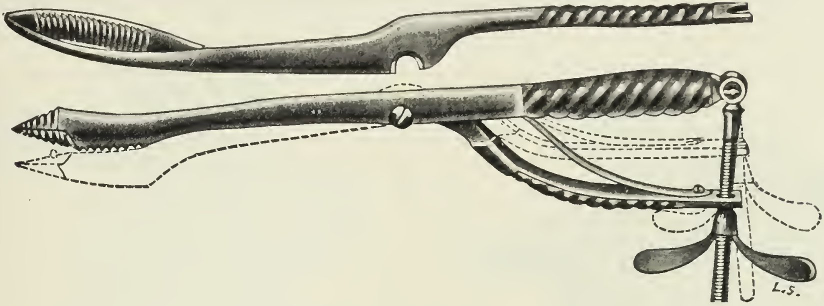

Fig. 471.—Simpson's Basilyst, Disarticulated.

At present *evisceration* is rarely employed, though it occasionally becomes necessary in order to effect the delivery of certain monstrosities, or of children suffering from unusual enlargement of the thoracic or abdominal cavities resulting from tumor formation. It may likewise become necessary in rare cases of transverse presentation, when the thorax or abdomen of the child lies over the superior strait and the neck is not accessible. In such circumstances an opening is made by scissors through the thoracic or abdominal wall, as the case may be, sufficiently large to admit two fingers, with which the viscera are torn loose from their attachments and slowly extracted.

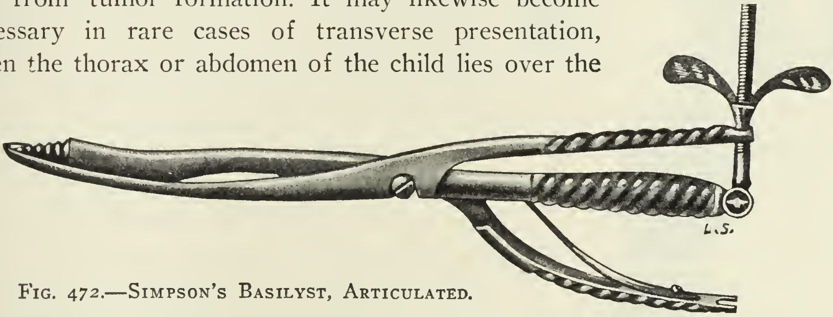

Fig. 472.—Simpson's Basilyst, Articulated.

Decapitation is much more frequently employed, and is indicated more particularly in *neglected transverse presentations.* As a rule, when seen early, such cases can be readily delivered by version and extraction; but when the condition has been overlooked, and assistance is not called for until one shoulder has become firmly impacted in the pelvic canal, the lower uterine segment may have become so stretched as to make an attempt at version practically synonymous with rupture of the uterus. Under such circumstances the child can be delivered only by decapitation or cesarean section. The former is the operation

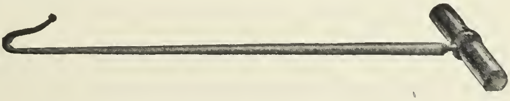

Fig. 473.—Braun's Blunt Hook.

of choice in neglected cases, and should always be chosen if the child is dead. It can readily be accomplished by means of Braun's blunt hook or of John Ramsbotham's sickle knife, which is extensively used in England.

Classical cesarean section is always associated with a high mortality in such circumstances, as the patient has usually been neglected and exposed to serious danger of infection. In most such cases the child has usually died before the patient is seen. If, however, it is in good condition, as indicated by strong fœtal heart sounds, and the mother is earnestly desirous of offspring, cesarean section followed by supravaginal hysterectomy may be undertaken if the patient is a multipara; whereas it should not be considered in the case of a primiparous woman, since the loss of a child with somewhat dubious chances of life should be regarded as a lesser evil than permanent sterilization.

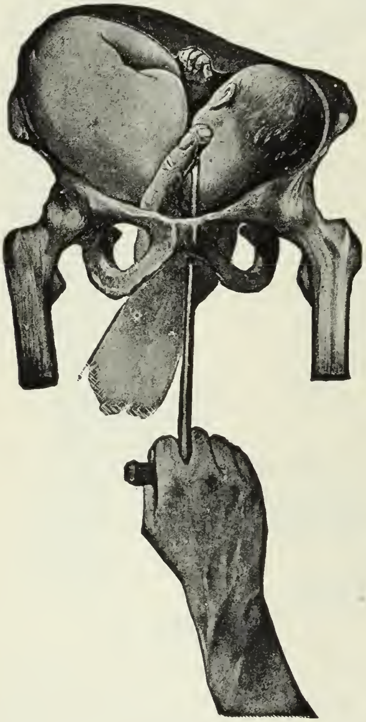

Fig. 474.—Decapitation with Braun's Blunt Hook (American Textbook).

Fortunately, in neglected shoulder presentations, decapitation is usually materially facilitated by the prolapse into the vagina of one arm. This having been seized and brought through the vulva, firm traction should be exerted upon it so as to put the neck on the stretch as much as possible. The index finger of one hand is then passed over the neck and used as a guide in applying Braun's hook as accurately as possible. When in position, the tip of the instrument is covered by the finger so as to avoid wounding the maternal soft parts. All being in readiness, strong traction is now made upon the handle of the instrument, which at the same time is rotated from side to side, somewhat as a key in a lock, by which the cervical vertebræ are disarticulated, and on continuation of the motion the neck is readily severed from the body. If any resistance is offered by the skin, it may be cut with scissors. After decapitation the body is extracted by traction upon the arm; or, if that be not available, by version. The head can frequently be expressed from the uterus by maneuvers similar to those employed for the delivery of the placenta, but if these prove unsuccessful a finger is inserted into the mouth of the child, after which, as a rule, extraction is readily effected by traction upon the lower jaw. If this is not effectual delivery can be accomplished by means of a cephalotribe or after perforation.

Zweifel believes that decapitation can be rendered easier by the use of the *trachelorhekter,* which consists essentially of a double Braun's hook. So far as my own experience goes, I see no necessity for the instrument, as I have always been able to effect decapitation by means of Braun's hook. Again, if the latter be not available, the operation may be performed by means of a pair of long curved scissors, similar to the embryotomy scissors of Hodge.

Occasionally, in head presentations, the excessive size of the shoulders may prove a serious obstacle to labor. In such cases *cleidotomy* renders excellent service. In this operation a pair of long curved scissors are introduced under the guidance of the hand and cut through the clavicles on either side, after which the shoulder girdle collapses and delivery is readily effected. According to Ballantyne, cleidotomy was first proposed by Herbert R. Spencer, instead of von Herff as is usually stated.

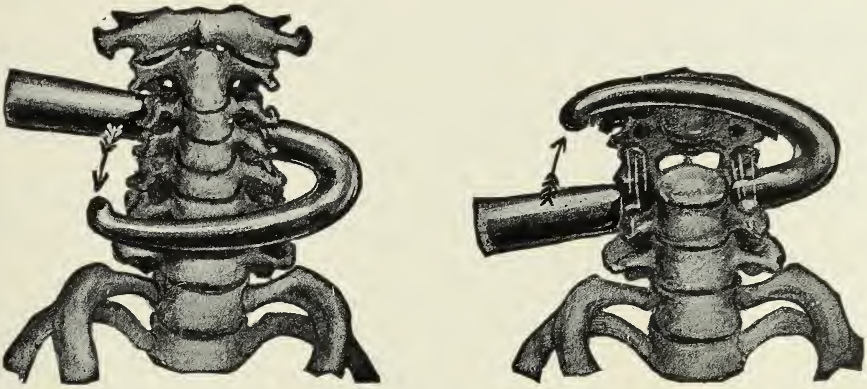

Fig. 475. Fig. 476.

Figs. 475, 476.—Showing Mode of Action of Blunt Hook (American Textbook).

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CHAPTER XXIV

OPERATIVE PROCEDURES WHICH DO NOT AIM AT DELIVERY

In this chapter will be considered a number of procedures usually designated as minor operations, which may become necessary during pregnancy, labor, or the puerperium.

The Douche.—We distinguish between vaginal and uterine douches, according as a considerable quantity of fluid is injected into the vaginal canal alone or directly into the uterine cavity.

Vaginal Douche.—Following the introduction of antiseptic methods into obstetrics, the use of an antiseptic, *prophylactic vaginal douche* becames a routine part of the conduct of labor, in the belief that by its means the countless pathogenic micro-organisms supposed to exist in the vaginal secretion of pregnant women could be destroyed, or at least rendered innocuous, and the risk of auto-infection minimized. Experimental work, however, has shown that, with the exception of the gonococcus, the vaginal secretion at the end of pregnancy rarely harbors pyogenic bacteria, and that the prophylactic vaginal douche is unnecessary. Furthermore, clinical experience has demonstrated that it is not only useless but even directly harmful, as its routine employment is followed by a greater incidence of febrile puerperia than when it is omitted. This question will be dealt with more fully in the chapter upon puerperal infection.

At the present time the vaginal douche is employed only exceptionally during pregnancy and labor; as, for instance, when the pregnant woman presents a profuse vaginal discharge due to gonorrheal infection. In such cases four liters of a hot 1:10,000 bichloride or permanganate solution may be injected into the vagina twice daily during the last few weeks of pregnancy, not so much in the hope of curing the disease as of avoiding infection of the child's eyes during labor. This is all that can reasonably be expected, inasmuch as the gonococci have usually invaded the glands of the cervical canal, where they are protected from the action of the antiseptic fluid.

Formerly, the employment of a prophylactic vaginal douche was recommended if the patient had been subjected to repeated examinations during labor by persons who habitually neglect ordinary aseptic precautions, and particularly if signs of infection are present. Owing to the impossibility of thoroughly disinfecting the vagina by antiseptic solutions, the value of such a procedure is questionable. A douche of several liters of hot sterile salt solution probably does no harm, but I do not use it.

After the first week of the puerperium, the vaginal douche is frequently employed when the lochia present an offensive odor. It need hardly be said, however, that it is of but little value as a disinfectant but merely removes mechanically the secretion collected in the vagina, and thus adds to the comfort of the patient. Sterile salt solution, or a weak solution of carbolic acid, either alone or combined with boric acid and a little oil of peppermint, may be employed.

Before giving a vaginal douche, the external genitalia should be carefully cleansed and the patient placed upon a douche pan as she lies in bed, or brought to the edge of the bed and placed in the obstetrical position with a rubber pad beneath her. A fountain syringe, containing four quarts and provided with an appropriately shaped glass nozzle, previously sterilized by boiling, is employed, and the fluid allowed to run in under moderate gravity pressure. The administration of the douche should not be intrusted to the nurse, unless one is assured of her competency.

Occasionally, when a puerperal infection has become localized, and has given rise to induration at the base of the broad ligament or in Douglas's culdesac, the application of heat by means of abundant douches of hot boiled water or salt solution alleviates suffering, hastens the maturation of the abscess, and prepares the way for its prompt evacuation.

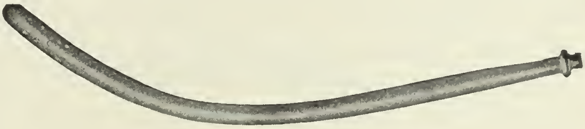

FIG. 477.—GLASS DOUCHE TUBE.

Intra-uterine Douche.—The intra-uterine douche is not employed so long as the uterine cavity is occupied by the product of conception, but is frequently used immediately after labor and during the puerperium.

Formerly it was customary to give an intra-uterine douche after all obstetrical operations. Such a procedure, however, is indicated only when the patient has exhibited signs of infection during labor; in these cases an intra-uterine douche of several liters of hot salt solution given after the completion of the third stage does no harm and occasionally may be productive of good effect.

The most usual indication for its employment immediately after labor is afforded by *postpartum hemorrhage* due to atony of the uterus. In such cases the administration of a douche of 4 or 5 liters of hot sterile salt solution will usually lead to efficient and permanent contraction, provided that no fragments of the placenta are retained *in utero*.

The intra-uterine douche is also frequently employed during the puerperium, especially in the presence of *infection*. It has, however, been greatly abused; for, while it must be admitted that it may be useful in mechanically removing débris from the uterine cavity, it is nevertheless true that it may be directly harmful. For these reasons great care should be taken in the selection of the cases in which it is employed. Generally speaking, it is contra-indicated whenever the infection is of streptococcic origin, inasmuch as the necessary manipulations may give rise to an extension of the process. On the other hand, when the symptoms are due to infection by the so-called putrefactive organisms, associated with retention of the lochial discharge, the introduction into the uterus of several liters of hot salt solution is sometimes followed by an immediate fall of temperature and a permanent improvement in the condition of the patient. If a single douche does not bring about the desired result, its repetition is generally useless.

Sterile salt solution should be employed for intra-uterine douching, instead of the antiseptic solutions which were formerly recommended, since the latter, no matter how strong they may be made, can act only in a purely mechanical way, and cannot destroy the bacteria which have already invaded the endometrium. On the other hand, their use occasionally causes the death of the patient, and, when bichloride of mercury was freely employed, many deaths from mercurial poisoning were recorded following intra-uterine use.

Inasmuch as the administration of an intra-uterine douche must always be regarded as a serious matter, it should be given by the physician himself and not delegated to the nurse, no matter how competent she may be; since the most rigid aseptic precautions are necessary, and failure in this regard may result in additional infection of the patient. As a preliminary, the vagina should be douched out. Two fingers having then been employed to locate the external os, the douche tube is passed through it until it impinges upon the fundus of the uterus. Four or five liters of fluid are then slowly injected, care being taken to insure a free return flow.

During the puerperium the cervical canal rapidly diminishes in caliber, and, owing to the marked anteflexion of the uterus which frequently occurs in that period, may become so bent as to offer a considerable obstacle to the introduction of the nozzle. To overcome this difficulty, traction should be made upon the anterior lip of the cervix by means of a pair of bullet forceps, when the cervical canal becomes straightened out. Occasionally, the contraction ring offers an obstacle, and the nozzle is arrested in the collapsed lower uterine segment. By making traction upon the cervix, and cautiously moving the extremity of the douche tube, it can usually be passed into the uterine cavity without further difficulty.

Curettage.—By this term is understood the removal of the lining membrane of the uterus and of structures adherent to it by means of a curet. The operation may be indicated in three conditions: incomplete abortion, imperfect involution of the puerperal uterus, and certain cases of infection.

When portions of the placenta and membranes are retained within the uterus after an *incomplete abortion,* many authorities recommend their removal by means of a dull curet. As a preliminary, the cervix, if not sufficiently pervious, must be dilated by a suitable instrument, preferably that of Goodell or Hegar (see Fig. 359). The blunt curet is then introduced into the uterus and gently scrapes off the retained structures. The employment of an instrument, however, is rarely advisable, as it is far better to peel off the adherent placenta and membranes with a finger, whose movements are controlled by the other hand, through the abdominal walls. After they are once loosened, the retained structures can be readily removed by means of the finger or by an ovum forceps. The former procedure postulates that the cervix be sufficiently dilated to admit the index finger, and necessitates the introduction of the entire hand into the vagina, and can only be accomplished under anesthesia.

After the uterus has been emptied in such cases, the finger is again introduced and carefully palpates its cavity, in order to make sure that the offending structures have been entirely removed and thereby to avert all danger of subsequent hemorrhage. If the curet alone is used, considerable portions of placenta may be left behind, which may later give rise to bleeding and necessitate another operation. On numerous occasions I have seen patients in consultation in whom hemorrhage had persisted after curettage, and on examination found that considerable portions of the placenta, or even the entire ovum, had been left in the uterus, the physician having removed only a part of the decidua at the previous operation. Moreover, curettage always carries with it the possibility of perforating the uterus, the walls in many cases being so soft and friable that the accident may occur despite the exercise of the utmost caution. Fortunately, the injury is generally attended by but little danger, although, if the uterine contents be infected, it may give rise to fatal peritonitis; again, in rare cases, a loop of gut may prolapse through the rent in the uterus and necessitate a major operation.

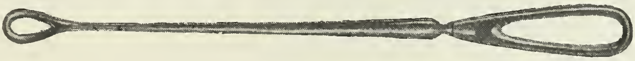

Fig. 478.—Curet.

Probably the most justifiable indication for curettage in obstetrical practice is the loss of blood after the first two weeks of the puerperium, resulting from *imperfect involution of the uterus,* which is sometimes associated with the retention of portions of the placenta or membranes. In such circumstances the operation gives excellent results, provided it be carried out in an aseptic manner.

Formerly, most authorities recommended curettage in *puerperal infection,* in the belief that by its means the focus of infection could be removed. The operation is undoubtedly beneficial in a small number of cases, but should be instituted only in the presence of definite indications, as its routine employment is much more dangerous than the original infection, and has led to the death of many hundreds of women. It is always contra-indicated when the infection is due to the streptococcus, as under such circumstances the lesions attending its use open up new areas for the spread of the infection. On the other hand, it is sometimes followed by excellent results when the so-called putrefactive organisms are producing the mischief, and particularly when the uterine cavity contains necrotic tissue or larger or smaller portions of degenerated placenta. Nevertheless, even in this class of cases it is generally better to employ the fingers in emptying the uterus.

The Tampon or Pack.—The vaginal tampon is occasionally indicated in the following conditions: inevitable abortion, certain cases of placenta prævia, and to dilate the cervix in the early months of pregnancy. Profuse hemorrhage occurring in the early months of pregnancy usually indicates that *abortion* is inevitable. In such cases, if the cervical canal is not sufficiently dilated to admit the finger, and instrumental dilatation does not seem indicated, it is sometimes advisable to pack it and the vagina tightly with sterile gauze. When the packing is removed twelve or twenty-four hours later, the product of conception is frequently found lying free in the vaginal vault, and when this does not occur the cervical canal will usually be sufficiently dilated to permit the introduction of the finger, by means of which the uterus can be emptied.

In *placenta prævia,* when the hemorrhage is alarming and the cervical canal is not sufficiently dilated to admit a finger, certain authorities recommend the application of a tight tampon to the cervical canal and vagina. I have never employed it in such circumstances, but it is claimed that it effectually controls hemorrhage, and on removing the pack a few hours later the cervix will usually be sufficiently dilated to admit two fingers, after which combined version by the Braxton Hicks method can be performed, or a Champetier de Ribes's balloon introduced. In the early months of pregnancy a tightly applied pack offers an uncertain means of *dilating the cervix* in any condition which demands the evacuation of the uterine contents, and rapid instrumental dilatation appears undesirable. In such cases, however, I prefer to evacuate the uterine cavity in one sitting by means of vaginal hysterotomy.

The best material for a vaginal tampon is gauze, which is most conveniently handled in the shape of roller-gauze bandages 4 inches wide, which have previously been carefully sterilized. For the introduction of the pack, the patient should be brought to the edge of the bed and prepared as for an operation. A bivalve, or preferably a Simon speculum is then introduced into the vagina and the cervix brought into view by means of a bullet forceps. Then with a long dressing forceps the bandage is carried up and tightly packed into the cervical canal, and afterward into the fornix, so that eventually the entire vagina is completely filled with it.

Intra-uterine Pack.—Dührssen, in 1887, advocated packing the uterine cavity with iodoform gauze as a means of controlling hemorrhage. Whenever there is persistent loss of blood following the third stage of labor, which does not yield to the ordinary methods of treatment, this procedure offers a most efficient method of controlling it, as the pack not only exerts pressure upon the bleeding vessels, but mechanically stimulates the uterus to vigorous contraction. Plain sterilized gauze is preferable to that impregnated with iodoform or other antiseptics. It is most conveniently prepared for use in the shape of strips 8 yards long, each folded four times upon itself so as to give a bandagelike arrangement two inches wide, with the free edge hemmed, and with a tape attached to one end to facilitate its withdrawal. Six such packs should be sterilized in a package and a number of packages always kept available for immediate use.

Before resorting to this procedure, however, it is essential that the hand be introduced into the uterus in order to ascertain that the hemorrhage is not due to retention of portions of the placenta. If the uterus is empty, after the usual preparations for an operation have been carried out, one blade of a Simon speculum is introduced and the posterior vaginal wall retracted; the anterior lip of the cervix is then seized with a bullet forceps and drawn down as near as possible to the vulva, after which sterilized bandages are rapidly packed into the uterine cavity by means of a long dressing forceps, the upper part of the vagina being also tamponed (Fig. 479).

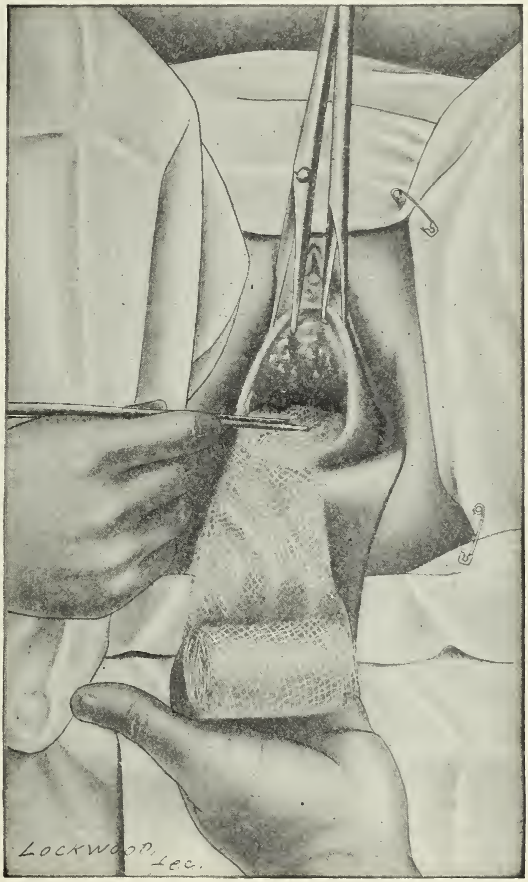

Fig. 479.—Packing the Uterus for Postpartum Hemorrhage.

Rudolph W. Holmes, in 1902, devised a tubular device for packing the uterus, which I have employed with great satisfaction, and which should always form part of the equipment of an obstetrical operating room. These packers are 30 centimeters in length, slightly curved so as to conform to the shape of the birth canal, vary in internal diameter according to the purpose for which they are to be used, and are provided with an obturator and a pronged staff (Fig. 480). For postpartum use, I prefer one with a bore of 2 centimeters. With the obturator in place, the instrument is carried up into the uterus until its end impinges upon the fundus, the obturator is then removed, the gauze introduced into the free end of the tube and rapidly fed into the uterus by means of the pronged packer. As soon as one pack has been introduced, it should be followed by another, three or four usually being required to fill tightly an atonic uterus. This device makes unnecessary the use of speculum and bullet forceps, has the advantage of reducing to a minimum the possibility of contamination by contact with the external genitalia, and greatly increases the rapidity with which the pack can be applied. By whatever method it has been introduced, the pack should be allowed to remain in place not longer than twenty-four hours, on account of the danger of infection. Removal is readily effected by traction upon the tapes, and one should make certain that the number of packs removed corresponds to that introduced.

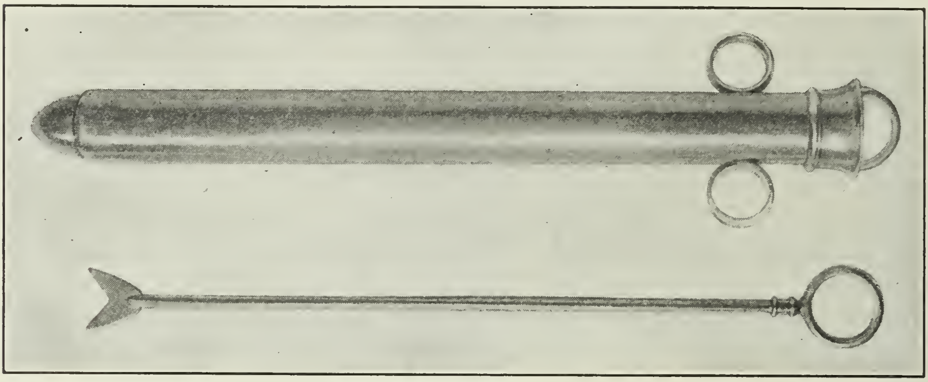

Fig. 480.—Holmes' Uterine Packer.
Above, obturator in place. Below, packer.

Manual Removal of the Placenta.—When considering the treatment of the third stage of labor, it was pointed out that previous to the introduction of Credé's method of expressing the placenta its manual removal was frequently resorted to. With increasing knowledge as to the proper conduct at this time, however, the operation became less and less frequently demanded, so that at present competent obstetricians consider that it is indicated only once in several hundred labors, and then only when abnormal adhesions exist between the placenta and the uterine wall, or when one has to do with a placenta membranacea or succenturiata.

Manual removal is indicated whenever there is alarming hemorrhage and the placenta cannot be expressed by Credé's method, though such a condition is but rarely observed. On the other hand, if there is no hemorrhage, the operation should not be resorted to merely to hasten the completion of the third stage of labor. Generally speaking, in such cases, repeated attempts at expression by Credé's maneuver should be persisted in for at least an hour, under anesthesia, if necessary, and manual removal should not be thought of until after prolonged effort has shown that more conservative methods are ineffectual. The procedure is attended by a greater danger of infection than any other obstetrical manipulation. In the ordinary operations, such as forceps and version, the hand, when introduced into the uterus, is within the amniotic cavity, and consequently microörganisms which may have been introduced along with it are cast off when the afterbirth is expelled; whereas, in manual removal of the placenta the hand is inserted between the fœtal membranes and the uterine wall, and, in separating the placenta from its attachments, comes in direct contact with the thrombosed sinuses. The latter may be regarded as blood-serum culture tubes awaiting inoculation, so that if pyogenic bacteria are introduced, abundant facilities for their further growth are offered.

When the operation becomes necessary, the strictest attention should be given to every aseptic detail. The external genitalia should be rigorously cleansed, the hands and forearms of the operator redisinfected, and encased in freshly boiled rubber gloves. After grasping the uterus through the abdominal wall with one hand, the other, lubricated with sterile vaseline, is introduced into the vagina and passed into the uterus, following the umbilical cord. As soon as the placenta is reached, its margin should be sought for, and the ulnar margin of the hand insinuated between its margin and the uterine wall. Then, with the back of the hand in contact with the latter, the placenta should be peeled off from its attachment by a motion similar to that employed in cutting the leaves of a book. After its complete separation, the placenta should be grasped in the entire hand, but not extracted immediately, the operator waiting until the uterus contracts down firmly over the hand, which should then gradually be withdrawn.

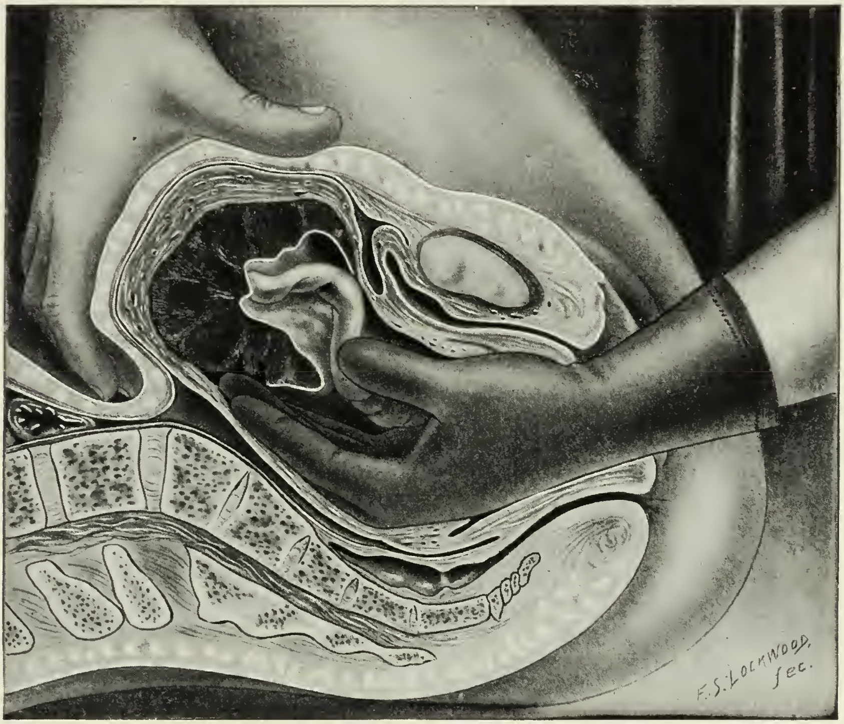

Fig. 481.—Manual Removal of the Placenta.

Once again, the importance of a most rigid aseptic technic in carrying out this procedure must be emphasized. Naturally, when the obstetrician finds himself face to face with an alarming postpartum hemorrhage, his only thought is likely to be as to the most rapid method of checking it, without regard to details. But even in such cases, the hand should be at least encased in a freshly boiled rubber glove; for, if introduced into the uterus without proper precautions, the patient, although saved from death from hemorrhage, may succumb to infection a few days later. That the operation is not without danger is shown by the analysis by Heidler and Steinhardt of one thousand cases in which manual removal was performed in Kermauner's clinic up to 1927. They reported a gross mortality of 8.02 per cent, and, after making every possible deduction, found that one woman out of every fifty perished directly from it.

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SECTION VI

PATHOLOGY OF PREGNANCY

CHAPTER XXV

ACCIDENTAL COMPLICATIONS OF PREGNANCY DUE TO DISEASE

Pregnancy may be associated with certain diseases which result from the condition itself, or by others which are to be regarded as accidental complications. The latter may have existed before the inception of pregnancy, or may have been acquired during its course.

As a rule, all diseases which subject the organism to a considerable strain are more serious when occurring in the pregnant woman. Thus, a lung which is partially destroyed or thrown out of function may suffice for the respiration of an ordinary individual, but be unable to respond to the added demands of pregnancy, particularly in the later months, when the enlarged uterus restricts the mobility of the diaphragm. Similarly, many a woman is unaware of the existence of a cardiac lesion, or at least leads a very comfortable existence, until the increased demands upon the activity of the heart incident to pregnancy bring about broken compensation with its attendant symptoms.

In general, it may be said that pregnancy exerts a deleterious influence upon most chronic organic maladies, while its effect is usually less marked in acute infectious processes. The latter, however, frequently lead to premature delivery, and the additional physical strain attending the latter may render the course of the disease much less favorable.

Pregnancy Complicated by Acute Infectious Diseases.—*Smallpox.*—Smallpox complicating pregnancy carries with it a more serious prognosis than at other times. Thus Vinay reported a mortality of 36 per cent in 235 cases, as compared with 25 per cent in the nonpregnant condition. The hemorrhagic form of the disease is particularly fatal in pregnant women, Mayer having recorded the loss of 13 consecutive cases.

Moreover, smallpox exerts a deleterious influence upon the product of conception, although the incidence of abortion or premature labor varies with the severity of the disease, Queirel stating that it is almost universal in the hemorrhagic, and comparatively infrequent in the discrete, variety. This may be due to hemorrhagic changes in the decidua, or to the direct transmission of the disease to the fœtus, with its subsequent death and expulsion. The occurrence of intra-uterine smallpox is well authenticated, children being occasionally born in the eruptive stage of the disease or with distinct pock-marks; as in the case reported by Puig y Roig, in which the mother presented no manifestations of the disease. Mauriceau is said to have been infected in this manner, and the condition was well known to John Hunter and Smellie. Moreover, in double-ovum twin pregnancy it sometimes happens that one child is definitely pock-marked, while the other shows no signs of the disease.

Bollinger first suggested the possibility of the transmission from mother to fœtus of the protective influence of vaccinia, and stated that when the mothers are successfully vaccinated during pregnancy a certain number of the children fail to take when vaccinated soon after birth. Behm noted this insusceptibility once in 29 cases, and believed that it was due to the transmission of an immunizing substance through the placenta. Kolloch held similar views. On the other hand, most authorities are skeptical as to the possibility of such an occurrence, and consider that unsuccessful vaccination in young children indicates that they are refractory to its influence, or that the virus was of poor quality. In 46 cases reported by Wolff, Palm, and Gast there was not a single instance of successful intra-uterine transmission.

Scarlet Fever.—It is generally believed that the pregnant woman possesses a certain immunity to scarlet fever. Braxton Hicks, Olshausen and others considered that this was demonstrated by the fact that the disease occurs much less frequently during pregnancy than in the puerperium. Poesch, in 1926, stated that less than 30 cases were recorded in the literature. It is quite possible that many of the puerperal cases were not examples of true scarlet fever, confusion having arisen on account of the somewhat similar rash which sometimes occurs in puerperal infection. The correctness of this latter supposition is supported by the fact that many authors believe in the intercommunicability of the two diseases, while the demonstration by Dick, Dochez and others that scarlatina is due to a specific hemolytic streptococcus certainly indicates that they are closely related.

When occurring in the early months of pregnancy, the disease sometimes causes abortion. This accident is usually attributed to the high temperature of the mother, though in very rare instances it is attributed to the direct transmission of the disease to the fœtus, Ballantyne having recorded a case in which the child presented a characteristic rash at birth, and Liddell and Tangye one in which they thought that desquamation and albuminuria proved the nature of the disease. This view, however, has never met with any general acceptation.

Measles.—Measles is not a frequent complication of pregnancy, but when it occurs is very prone to cause premature delivery, which was observed by Klotz in 9 out of 11 cases. According to Fellner, the prognosis is much more serious during the puerperium than during pregnancy. It is stated that intra-uterine transmission of the disease to the fœtus is now and again noted, Lomer, Fiori, and others having reported cases in which the child presented a characteristic eruption at birth.

Cholera.—Pregnant women do not appear to be attacked by cholera more frequently than others, although they succumb more readily to the disease. Schütz states that the mortality among them in the Hamburg epidemic of 1892 was 57 per cent.

The disease exerts a very deleterious effect upon pregnancy, 54 per cent of the cases, according to Schütz, ending in abortion or premature labor. This may be due to various causes. One-third of the women suffering from cholera have uterine hemorrhage, which, when occurring during pregnancy, must be associated with changes in the decidua, Slavjansky having described a peculiar form of hemorrhagic endometritis. Moreover, in nearly every instance, the disease causes uterine contractions, supposed to result from the circulation of toxins in the blood.

Tizzoni and Cantani are the only investigators who have demonstrated the transmission of cholera bacilli to the human fœtus; but Vitanzi's experiments render it probable that such an occurrence is quite frequent in animals.

Typhoid Fever.—Typhoid fever is a serious, and often a dangerous, complication of pregnancy. Moreover, it increases largely the fœtal mortality, abortion or premature labor occurring in from 40 to 60 per cent of the cases. Formerly it was held that the death of the fœtus and its subsequent expulsion were due to the high temperature characterizing the disease; but it is now known that it is usually due to the direct transmission through the placenta of toxins or of the bacilli themselves. Since F. W. Lynch, in our clinic, demonstrated the bacilli in the organs of a fœtus aborted by a woman suffering from typhoid fever, and Hicks and French stated that similar findings were noted in 10 out of 21 cases reported in the literature, it is generally admitted that the death of the fœtus is frequently due to a typhoid septicemia. The literature upon the subject was collected by Wichels, in 1924.

Pneumonia.—The maternal mortality is materially augmented when pneumonia occurs during pregnancy, since the disease frequently leads to premature labor or abortion. This result is generally attributed to imperfect oxygenation of the fœtal blood, though it is frequently due to the direct transmission of bacteria to the fœtus, in whose organs pneumococci have been demonstrated by Levy, Netter, Carbonelli, and Lubarsch, as well as in several cases in our service, which will be reported by R. G. Douglas. Premature labor is a very untoward complication in such cases, as the exertion incident to it subjects the already weakened maternal organism to so great an additional strain that death frequently results.

When pneumonia develops during the last days of pregnancy or early in the puerperium, it is not unusual for pneumococci to be transmitted by means of the blood stream to the uterus where they give rise to hematogenous puerperal infection. Johnston and Morgan described such a case occurring in our service, and collected the literature upon the subject up to 1922.

Influenza.—Our experience during the pandemic of 1918 shows that influenza constitutes an unusually serious complication of pregnancy, more particularly when of the pneumonic type. J. W. Harris, in a statistical study based upon 1350 cases, found that the gross maternal mortality was 27 per cent, which increased to 50 per cent when pneumonia developed. The disease also has a most deleterious effect upon the pregnancy, which was interrupted in 26 per cent of the uncomplicated cases, and in 52 per cent of those accompanied by pneumonia. Moreover, when the disease ended fatally spontaneous termination of pregnancy occurred in 62 per cent of the cases before the death of the mother.

In other words, the occurrence of abortion or premature labor adds to the gravity of the disease—a fact, which, in our judgment, effectively demonstrates the unjustifiability of terminating pregnancy artificially in the hope of improving the prognosis for the mother. On the other hand, in many of the mild cases, the disease runs a benign course, and has no effect upon the pregnancy, thereby partially confirming the opinion of Bar and Boullé that it is almost without influence upon the course of gestation.

Erysipelas and Sepsis.—Erysipelas is a very serious disease at any time, but is particularly dangerous when occurring in pregnant women, on account of the danger of the development of puerperal infection. That this does not always occur is shown by the fact that I have delivered several women suffering from severe facial erysipelas without the occurrence of uterine infection. Occasionally, as noted by Lebedeff, the streptococci, the cause of the erysipelas, are transmitted from mother to child, but this is unusual. A general septicemia sometimes follows a streptococcic angina, and in such cases streptococci can be found in the uterine lochia, as well as in the fœtal blood.

Furthermore, as a rule, any septic condition offers a worse prognosis in pregnancy than at other times. Krönig has reported several instances of the passage of the offending bacteria through the placenta to the child, having demonstrated the transmission of the colon bacillus, as well as of an anaërobic bacillus, from localized inflammatory processes.

Gonorrhea.—The occurrence of gonorrhea in the pregnant woman should never be lightly regarded. In not a few instances the organisms invade the decidua and give rise to inflammatory conditions which lead to abortion. Gonococci were demonstrated in decidual endometritis by Neumann and Maslovsky as early as 1896, and I have found them repeatedly.

More important, however, are the consequences of gonorrheal infection at the time of labor and during the puerperium, leaving out of consideration ophthalmia neonatorum, to which reference has already been made. After labor the gonococci, which have remained limited to the cervical canal during pregnancy, may gain access to the uterine cavity and give rise to febrile phenomena. The condition, although rarely fatal, is always serious, and will be considered in detail in the section on Puerperal Infection. In rare instances the gonococcus may produce a general infection, Dabney and Harris, and J. T. Smith having reported fatal cases of gonorrheal endocarditis observed in women delivered at the Johns Hopkins Hospital.

Tetanus.—Always a very dangerous disease, tetanus is fortunately a rare complication of pregnancy, nor does it appear to be more fatal than in nonpregnant women. Archambaud has reported a case which terminated favorably.

Anthrax.—Anthrax, or malignant pustule, is rarely observed in human beings under any circumstances, but is almost always fatal. Rostowzen met with three deaths in pregnant women, and was able in each case to demonstrate anthrax bacilli in the tissues of the child. A similar observation was made by Paltauf. Moreover, in certain animals the placental transmission of anthrax can frequently be demonstrated experimentally. The first observations of this character were made by Strauss and Chamberlent in 1882.

Pregnancy Complicated by Chronic Infectious Diseases.—*Tuberculosis.*—Under the influence of German teachings, it is generally believed in this country that tuberculosis complicating pregnancy usually undergoes exacerbation, and consequently that abortion should be induced in the interests of the mother whenever the existence of the disease is detected during the first five months; but, when recognized later, intervention is not indicated, for the reason that the induction of premature labor is followed by as serious results as delivery at term. In France, on the other hand, more conservative views prevail——many authorities declining all intervention, and others holding that it is indicated only in exceptional cases.

For years, I held radical views upon the subject, but in 1926 I was forced to reconsider them, as the result of a study by Bridgman and Norwood of 134 cases from my service. These patients were followed for one year or longer, and at the end of that time it was found that more deaths had occurred in those upon whom abortion had been induced than in those who were left alone. As a result, I was forced to inquire whether or not I had benefited my patients by radical intervention.

Forssner of Stockholm, in 1925, arrived at still more revolutionary conclusions, and believed that he was able to show that pregnancy exerted little, if any, influence upon the course of tuberculosis. With the aid of several specialists, he compared the results obtained in 341 women who had been delivered, with those in 396 other women who had been treated in the tuberculosis dispensary, but who had not been pregnant. At the end of two years, it was found that the mortality was essentially identical in each group, being very low when the tuberculosis was mild, higher when it was moderately advanced, and very high in the most severe types. Consequently, Forssner believes that intervention is never indicated, and when practised, probably does more harm than good.

It is, however, well known that many women, who do apparently well during the course of pregnancy, grow rapidly worse after its conclusion, especially if they suckle their children. Consequently, suckling should always be forbidden, not only in the interests of the mother, but also to protect the child from the possibility of infection.

While I am no longer a radical interventionist, I regard the occurrence of pregnancy in women with active tuberculosis as a great misfortune, and consequently I recommend the prevention of pregnancy by the most available contraceptive methods, and, when the patients are too ignorant or indolent to employ them, I do not hesitate to resort to sterilization by operative means. On the other hand, I do hesitate to induce abortion except under unusual conditions, but I occasionally do so when the process is evidently progressing and when competent experts assure me that intervention offers the only hope for the patient. Furthermore, I sometimes interfere when pregnancy has followed unsuccessful attempts at contraception, and the patient is prepared to make serious sacrifices to arrest the disease by intelligent hygienic and climatic treatment.

As a rule, tuberculosis of the mother does not affect the child, and it is not unusual for it to be splendidly developed. On the other hand, the disease is occasionally transmitted *in utero* so that the child is born with congenital tuberculosis. Whitman and Greene, in 1922, were able to collect 38 cases with characteristic histological findings, as well as 21 others in which bacilli could be demonstrated in the fœtus and placenta, but without histological lesions. Couvelaire, on the other hand, believes that placental transmission occurs relatively frequently, and bases his belief upon the existence of the so-called "ultravirus" of Calmette. The latter holds that tuberculosis may be transmitted not only by the actual bacillus, but also by a virus, which can pass through a Chamberlent filter, and from which bacilli later develop.

It appears, however, that in the vast majority of cases, the disease is not transmitted directly through the placenta to the fœtus, but that the latter is born with a lessened resistance rather than with tuberculosis itself. Hence, it follows that such children should be brought up under the best hygienic surroundings and should not suckle their mothers.

Following the description by Lehmann of the first cases of placental tuberculosis, the subject has been carefully studied by many investigators. Novak and Ranzel collected 39 such cases in 1910, while Whitman and Greene increased the number to 47 in 1922. As the former investigators found tubercle bacilli in 7 out of 10 placentæ from women in various stages of the disease, it is apparent that the condition occurs more frequently than is generally believed, and confirms the opinon of Baumgarten and Maffucci that the incidence of congenital tuberculosis is generally underestimated. According to Lanz tubercular lesions of the placenta may occur in the following forms: (1) tubercles attached to the periphery of the chorionic villi, but projecting in great part into the intervillous spaces; (2) tubercles in the stroma of the villi, which are due to bacilli which have penetrated the villous epithelium; (3) tubercular changes in the chorionic membrane, and (4) caseous tubercular deposits in the decidua basalis. Of these, (1) and (4) are the most frequent, while (2), which is the lesion most concerned in the production of congenital tuberculosis, has only occasionally been observed. Strange to say, although

I have examined histologically many thousand placentæ, and have always borne the possibility of placental tuberculosis in mind, I have not observed an example up to this time.

The possibility of germinal infection should also be borne in mind. Friedmann, in experiments upon the rabbits and guinea-pigs, showed that tubercle bacilli may be carried to the ovum by means of the spermatozoa; while Sitzenfrey has demonstrated in women dying from tuberculosis the presence of bacilli in the interior of ova while still within the graafian follicles. It is, of course, questionable whether such infected ova could go on to development, but should it occur, the supposition that the bacilli might lie dormant for some time would afford a plausible explanation for the cases in which the tuberculosis does not become manifest until some time after birth.

Malaria.—Despite the somewhat widespread opinion to the contrary, it would appear that the ordinary forms of malaria have but little influence upon the course of pregnancy, although Goth has reported that 19 out of 46 cases ended in premature labor.

In spite of the fact that the fœtal mortality is high in localities where pernicious malaria prevails, there is no convincing evidence that placental transmission occurs. On the contrary, Blacklock and Gordon, in Sierra Leone, while able to demonstrate the presence of the characteristic parasites in the maternal blood of the placenta in 59 cases, never succeeded in finding them in the blood of the villous vessels nor in the umbilical cord. There is a marked tendency toward recrudescence of the disease during pregnancy and the puerperium, just as is frequently observed after surgical operations.

Quinine should be administered unhesitatingly to women suffering from malaria during pregnancy, as its oxytoxic properties are apparently in abeyance under such conditions, so that it can be used with impunity without fear of setting up uterine contractions.

Syphilis.—Syphilis is one of the most important complications of pregnancy, and before the institution of efficient prenatal care it constituted the most frequent single cause of fœtal death. In 1915, I reported that it was responsible for 26.4 per cent of the 705 fœtal deaths occurring in 10,000 consecutive labors under my supervision; including all deaths occurring after the period of viability had been reached, as well as during the first two weeks following labor. These figures, however, do not tell the whole story of the ravages of the disease, for many children who were discharged alive, either died soon afterwards or presented manifestations of hereditary syphilis later in life. Furthermore, syphilis was demonstrated as the etiological factor in 40 per cent of our dead-born premature infants and in approximately 80 per cent of the macerated children, and consequently it should be suspected whenever a perfectly satisfactory explanation for the occurrence of premature labor cannot be adduced. On the other hand, it plays little, or no, part in the causation of early abortion. In 1920, I reported that a positive Wassermann reaction was present in 11.2 per cent of 4547 consecutive women passing through our service, but was noted much less frequently in white than in black patients—2.5 and 16.3 per cent, respectively.

When infection occurs during pregnancy, owing to the vascularity of the parts, the initial sore may assume larger proportions than under ordinary circumstances. The secondary lesions, however, are often but slightly marked, and may be practically limited to the genitalia, where they appear as large, elevated areas which occasionally undergo ulcerative changes, and sometimes lead to the destruction of superficial portions of the vulva. In most patients, however, no history of a primary sore or of a rash can be elicited, and the first intimation of the existence of the disease is afforded by the birth of a premature or macerated fœtus, or by the demonstration of a positive Wassermann reaction. Indeed, it appears that syphilis in general runs a much less severe course in women than in men, and Warthin, in 1928, clearly pointed out the salient differences.

The syphilitic child is often dead when it comes into the world; less frequently it is born alive with definite manifestations of the disease. Again, in a still smaller number of cases, it may be born without signs of the disease, which, however, make their appearance later; while occasionally, particularly when the infection had occurred some years previously, the child may never manifest any signs of the disease. Moreover, my investigations have shown that syphilis is the actual cause of death in many children, which were apparently normal at birth, but succumbed some weeks later to what is usually designated as inanition or marasmus.

The influence of syphilis upon pregnancy differs materially, and three classes of cases are distinguished, according as infection has taken place: (1) before pregnancy; (2) at the time of conception, or (3) during pregnancy.

When inoculation with the specific poison has occurred before conception, and is not treated, the disease usually causes premature labor or the expulsion of a macerated fœtus. Le Pileur obtained a striking illustration of the disastrous effects of syphilis from a study of the reproductive histories of 130 women before and after its inception, 3.8 per cent of the children being born dead before, as compared with 78 per cent after, infection.

When the mother is suffering from an acute infection at the time of conception, the offspring is always syphilitic. The same applies when the infection and conception occur at the same time. On the other hand, when syphilis is contracted during pregnancy, its effect upon the fœtus varies. If infection occurs within the first months, the fœtus, as a rule, likewise manifests signs of the disease, but when it occurs later the child may not become infected.

Until recently it was generally believed that fœtal syphilis was frequently the result of paternal infection, and that a man suffering from the tertiary form might engender a syphilitic child without infecting his wife. This belief was based upon the observation that an apparently healthy woman might give birth to a definitely syphilitic child, and be able to suckle it with impunity, whereas it would certainly infect another woman. Such an occurrence was well stated in the dictum known as Colles's law, assuming spermatic infection and a transmission of immunity from fœtus to mother. Conversely, it was also believed that a definitely syphilitic mother might occasionally give birth to a healthy child, which would possess a definite immunity against the disease. Such observations gave the basis for Profeta's law.

With the discovery of the Spirochæta pallida by Schaudinn, and the utilization of the Wassermann reaction as a means of diagnosis, grave doubt has been cast upon the validity of these laws, which are now denied by the great majority of syphilographers. In order for paternal transmission to occur it is necessary to suppose that the syphilitic virus is transmitted to the ovum by means of the spermatozoön. As long as the virus was merely hypothetical this did not seem improbable; but when Bab pointed out that the spirochete is three times as long as the head of a spermatozoön, it appeared unlikely that the former could enter the ovum along with the latter, unless some sporelike intermediate form exists. Recent investigations concerning other varieties of spirochetes, of which mention was made by Strong in 1923, make it conceivable that this may be the case; as not a few investigators believe that a so-called granular stage represents an important phase in the life-cycle of certain spirochetes. Whether similar observations will be made for the Spirochæta pallida remains to be seen. Furthermore, the fact that the apparently healthy mothers almost universally present a positive Wassermann reaction has led most investigators to conclude that the immunity is only apparent, and is due to the fact that such women are really suffering from a latent syphilis, which has not given rise to symptoms.

It must be admitted that these arguments greatly impair the validity of Colles's law, as its acceptance implies the existence of a granular form of the spirochete, as well as the supposition that a positive maternal Wassermann may be due to "immunizing substances" derived from the syphilitic ovum. Nevertheless, I am not prepared to deny such possibilities, for the reason that Colles's law seems to offer a plausible explanation for certain definite clinical manifestations, and also because I cannot rid myself of the idea that the constant casting off into the maternal circulation of minute portions of the paternally infected ovum—in the shape of fragments of chorionic villi—would seem to offer an almost ideal means of bringing about active immunity. Boas and Hochsinger are the only syphilographers who share my views, and they state that the question is still *sub judice*. Moreover, both Boas and Fildes hold that syphilis on the part of the mother does not necessarily imply infection of the fœtus, and have adduced a considerable mass of figures in support of their contention.

Consideration of the syphilitic lesions of the child and the placenta will be taken up in the chapter upon Diseases of the Ovum.

Whenever we obtain a history of syphilis in either parent, no matter whether infection has occurred prior to or after conception, the mother should at once be treated by salvarsan, followed by a course of specific treatment; as by its means not only may she be cured, but, in view of the fact that the arsenical and mercurial salts, as well as iodide of potassium, are readily transmitted through the placenta, the fœtus is treated at the same time.

In hospital services for ward patients, one of the most important functions of prenatal care is the recognition and treatment of the syphilitic pregnant woman. As the great majority of such give no history of infection and present no visible manifestations of the disease, this can be accomplished only by routinely taking a sample of blood for a Wassermann test at the first visit. From our own experience, it is safe to say that if efficient treatment is instituted by the fifth month of pregnancy congenital syphilis can be almost entirely eliminated. Furthermore, the pregnant woman is unusually susceptible to its influence, so that it frequently happens that an amount of treatment which would be useless in the case of a man, makes the difference between the birth of an infected or a normal child. The as yet unpublished investigations of Nicholson J. Eastman in our service (1930) apparently supply an explanation for this phenomenon, as he has been able to show the salvarsan is stored in the placenta and is aparently supplied to the fœtus according to its needs.

The treatment, however, cannot be regarded as efficient, unless the maternal Wassermann reaction has remained persistently negative for at least one year after the administration of the last course of salvarsan. Consequently, the birth of an apparently normal child should be followed by sufficient additional treatment to insure the complete cure of the mother.

In view of the practical application of Colles's law, the syphilitic child may be suckled with impunity by its own mother. If, however, she is unable to nourish it, it should never be given to a wet-nurse, but should be fed artificially.

Diseases of the Circulatory and Respiratory Systems.—*Valvular Lesions of the Heart.*—During the decade beginning with 1920 many contributions have been made to this subject which have added greatly to our knowledge. Thus, the work of Frey, Jagic, Stander, Gammeltoft, and others has clearly shown that the normal heart undergoes definite hypertrophy during pregnancy, corresponding to its increased minute output; while the investigations of Sir James Mackenzie indicate that there normally occurs a certain amount of derangement in the cardiac function. He bases his conclusions upon the fact that the following conditions may frequently be noted: (1) limitation of the field of cardiac response; (2) changes in the rate and rhythm of the heart; (3) dilatation of the right side of the heart; (4) tendency to edema of the lungs; (5) tendency to overfilling of the veins of the legs, and (6) the occurrence of marked pulsation in the veins of the neck. As all of these conditions are more or less abnormal, and are likely to become greatly accentuated in pregnant women suffering from valvular lesions of the heart, there is good reason for considering such complications as serious.

The gravity of valvular disease complicating pregnancy is generally overestimated, and the mortality of 28 per cent reported by Guérard, which led him to consider the complication as more serious than eclampsia or placenta prævia, can be explained only by supposing that his material was made up almost entirely of cases in which compensation had long since failed, and did not include the mild and moderately severe cases which occur relatively frequently in large series of deliveries. The figures of Kellogg, Fellner, Frey, Jagic, and Jensen indicate that the incidence of serious lesions complicating pregnancy varies between 1 and 2.5 per cent, and that only a small percentage of the entire number end fatally. In about three-fourths of the cases the condition is so mild that the woman is not aware of her condition, while in the remainder decompensation may develop with more or less serious results.

In a series of 49 patients with rheumatic heart disease Jensen observed the following lesions:

Mitral insufficiency	23
Mitral stenosis	13
Mitral stenosis and insufficiency	11
Mitral and aortic insufficiency	2
TOTAL	49

Mackenzie holds that systolic murmurs without signs of heart failure are of little significance, and that, while mitral stenosis is more serious, its prognosis is variable. If the process is stationary, the size of the heart normal, its rate regular and the response good, the prognosis is good; whereas, if associated with enlargement of the heart, poor response and fibrillation, it is very serious.

From my own experience, I should say that apparently functional cardiac murmurs are frequently heard in pregnancy, while serious organic lesions occur about once in every one hundred cases. Ordinarily, even in the latter the symptoms are not alarming, but occasionally a break in compensation occurs associated with such signs of serious myocardial or endocarditic involvement that the artificial interruption of pregnancy seems to offer the only means of averting a fatal outcome.

Generally speaking, the prognosis is most serious in mitral stenosis, either alone or in association with insufficiency, and a certain number of patients will die whatever one may do. I agree, however, with most recent writers that even with this lesion the dangers are exaggerated provided the patient has been under observation during a considerable part of the pregnancy, and has received intelligent care. In such cases the prognosis depends less upon the character of the heart sounds and the area of cardiac dullness than upon the presence of myocardial or endocardial lesions, as manifested by the response of the heart rate and blood pressure to exercise.

Every pregnant woman with a heart lesion who presents any symptoms should immediately be put to bed and carefully studied, and it is frequently surprising to note how rapidly the symptoms of broken compensation yield to appropriate treatment, thus enabling the patient to go through pregnancy without any untoward symptom. On the other hand, it sometimes happens that women who appear to be much less ill, and yet show instability of the pulse and blood pressure, grow gradually worse and sometimes collapse at the time of labor. It is in this type of patient that pregnancy should be interrupted by the induction of premature labor or by cesarean section, as the case may be. It is, however, surprising how well most patients do, and since 1920 I have found it necessary to resort to cesarean section upon only three occasions.

It is generally admitted that the most untoward symptoms are observed in mitral stenosis. Lusk regarded this lesion as sufficiently serious to warrant the induction of abortion as soon as the diagnosis is made. This, however, is too extreme a view, although it must be admitted that this lesion is more apt to give rise to serious disturbances than all others combined. Thus, Kautsky found that mitral stenosis, either alone or associated with insufficiency, was responsible for the entire mortality in his series of cases. On the other hand, French and Hicks, after studying the obstetrical records of 300 women treated in Guy's Hospital for this condition, hold that it is no more serious than other lesions; and report that 135 of their patients went through 608 labors without a break in compensation. Frey takes a similar view, while Jagic holds that pregnancy should be interrupted in all serious cases.

Generally speaking, the prognosis is good so long as compensation is retained, and the myocardium is not seriously involved, whatever the lesion. To this, however, there are certain exceptions, as Zweifel has recorded two cases in which collapse and death occurred in pregnant women who had previously been absolutely unaware of their condition. On the other hand, if compensation fails, and rest in bed and appropriate therapy do not bring about amelioration of the symptoms, the prognosis becomes ominous; for even if the patient be saved from immediate death by the induction of premature labor, or by cesarean section, serious complications are usually in store for her in the future.

Grave heart lesions complicating pregnancy are generally believed to predispose to premature labor, which was noted in 20.2 per cent of Fellner's cases, as compared with 5.5 per cent in those of French and Hicks. This accident may result from uterine hemorrhage directly attributable to the cardiac condition, from the death of the fœtus due to insufficient oxidation, or from changes in the placenta. In not a few cases there is more or less profuse hemorrhage immediately following delivery; or again, at the time of labor, owing to the elevation of arterial pressure incident to the uterine contractions, compensation may fail and the woman's life may be in peril. Moreover, collapse may manifest itself immediately after the expulsion of the child, as a result of the marked fall in the arterial pressure which occurs at that time.

If the lesion is fairly compensated the pregnant patient should be kept under close observation, rest being ordered and digitalis or some other heart tonic being employed as soon as symptoms appear. If she is allowed to go on to term, owing to the psychical disturbances incident to labor, and the elevation of arterial pressure brought about by the abdominal and uterine contractions, it is advisable to make free use of an anesthetic and to minimize the exertion incident to the second stage. For this reason, as soon as the cervix is completely dilated and the head deep in the pelvis, the termination of labor by forceps is indicated.

Some authorities recommend that women suffering from heart lesions should be dissuaded from marriage, or, if married, from becoming pregnant. This, however, appears to be an extreme view, and should only apply when the lesion is serious and the compensation faulty. On the other hand, in multiparous women, in whom the lesion becomes accentuated in each succeeding pregnancy, contraceptive advice is indicated, and even sterilization may be justified in certain cases.

Endocarditis.—Acute endocarditis may appear during pregnancy, just as at other times. It should always be regarded as a serious matter, but particularly so at this time, as occasionally the bacteria giving rise to it may be transmitted to the fœtus and cause its death, while in other cases small portions of the vegetations upon the valves may be broken off and give rise to apoplexy or embolism.

Occasionally cases of tachycardia are observed during pregnancy for which no explanation can be given. Thus, in a multiparous patient the pulse rate varied between 120 and 140 during the last three months of each pregnancy, but returned to normal within a few days after delivery. As a thorough physical and urinary examination failed to reveal any abnormality, I was forced to make the unsatisfactory and provisional diagnosis of neurotic tachycardia.

Phlegmasia.—Thrombosis of the veins of the thigh, or phlegmasia, is a very rare complication of pregnancy. F. C. Goldsborough, in 1904, reported a case observed in my service and collected the literature upon the subject. Since then I have seen several additional cases. While there is no evidence that it is due to infection, as is the case with puerperal phlebitis, it should be regarded as a serious condition, particularly in view of the fact that incautious manipulations may lead to the detachment of small particles of a thrombus, which may then give rise to embolism of the pulmonary arteries. The symptoms and treatment are dealt with in Chapters XLIII and XLIV. On the other hand, thrombosis of the superficial vessels of the leg is frequently observed in women suffering from varicose veins, and can usually be regarded with equanimity.

Pulmonary Embolism.—Embolism of the pulmonary arteries is a much rarer complication of pregnancy than of the puerperium. Barnes reports one case which ended fatally within a few moments, while Sperling has reported a second which eventuated in recovery. The condition should always be borne in mind in cases of sudden death during pregnancy which cannot otherwise be explained.

Emphysema.—When pregnancy occurs in women suffering from advanced emphysema, the dyspnea may become so intense as to demand its artificial interruption. In a certain number of cases premature labor occurs spontaneously, the untimely uterine contractions being attributed to insufficient aëration of the blood.

Asthma.—The symptoms of asthma are sometimes markedly aggravated during pregnancy. In some patients the disease makes its appearance only during pregnancy or at the time of labor, disappearing spontaneously after childbirth.

If the usual methods of treatment fail, cure may sometimes be effected by placing the patient upon an absolute milk diet, although careful analysis of the blood and urine may not indicate the existence of a toxemia. If this is ineffectual, a radical change of air sometimes proves beneficial.

Dyspnea.—Almost every woman in the last few weeks of pregnancy suffers more or less from shortness of breath resulting from interference with the motility of the diaphragm by the enlarged uterus. Dyspnea occurring in the earlier months of pregnancy is usually due to cardiac or renal disease, and demands a thorough physical examination. Occasionally it follows excessive distention of the uterus, as in hydramnios.

Varices.—Owing to the pressure of the pregnant uterus upon the veins returning from the thighs, and the fact that they are but poorly supplied with valves, abnormalities in their circulation are frequently observed during pregnancy, and manifest themselves by the appearance of varicose veins. These may assume considerable proportions in the legs or about the vulva, and give rise to distressing symptoms. When situated in the latter location, their rupture may lead to fatal hemorrhage if medical aid is not available. When they occur in the legs, relief is often obtained by the use of neatly applied bandages or elastic stockings. Active treatment is useless in vulval varices, but the danger of their rupture at the time of labor should be borne in mind.

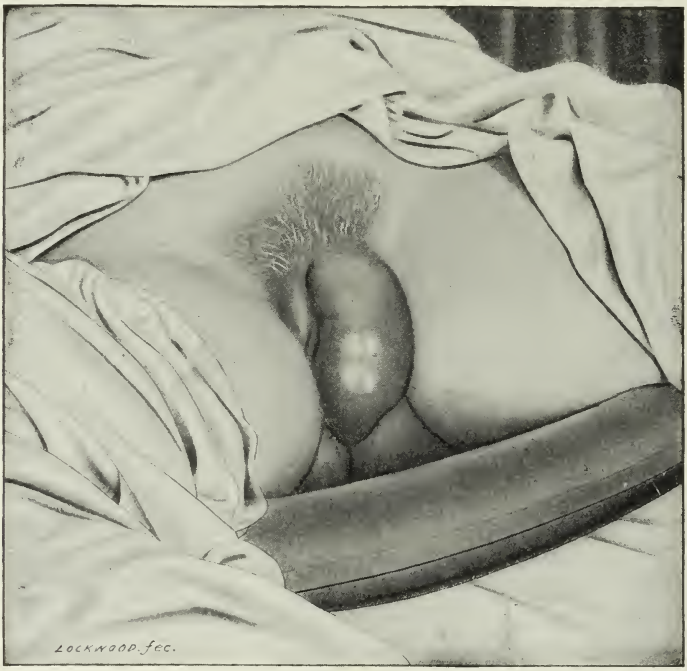

Fig. 482.—Edema of Vulva.

Edema.—Edema is a very frequent complication of pregnancy. It may be general and involve any portion of the body, but is usually limited to the lower extremities. Occasionally the vulva becomes intensely edematous. When limited to the extremities, the swelling was formerly attributed to pressure exerted by the enlarged uterus upon the veins returning from the legs, but Zangemeister considers it due to increased permeability of the capillaries, which he holds is part of a process peculiar to pregnancy—*hydrops gravidarum*—which is often the forerunner of a true toxemia and manifests itself before the blood pressure becomes elevated or albuminuria appears. In not a few instances, the condition may be recognized by an excessive gain in weight days before manifest edema appears. On the other hand, if the condition be generalized, it is likely to be a manifestation of toxemia, though occasionally it may be due to other causes.

The patient should be cautioned as to its significance, and whenever edema appears the urine should be carefully examined. If the kidneys are found to be doing their work properly, the swelling is probably of mechanical origin and can be relieved only by restricting the movements of the patient, or even confining her to her bed. If the urinary findings indicate the existence of a toxemia, the condition is more serious, and should be treated as will be indicated in the following chapter.

When the marked swelling about the vulva is a source of discomfort and annoyance, and is not relieved by medicinal treatment, relief may be given by puncturing the most dependent portions of the swollen labia and allowing the serum to drain off. This slight operation should always be done under the strictest aseptic precautions, and the labia afterward covered with sterile dressings, inasmuch as infection can readily occur and may be followed by serious consequences.

Diseases of the Alimentary Tract and the Liver.—*Icterus.*—Pregnancy is comparatively seldom complicated by jaundice, which is usually due to catarrhal process in the duodenum or to cholelithiasis. The catarrhal variety is generally without significance and undergoes spontaneous cure. At the same time, it should be borne in mind that jaundice may represent the onset of acute yellow atrophy of the liver; while its association with prenicious vomiting, toxemia or eclampsia is indicative of profound lesions in the liver, and adds greatly to the seriousness of the prognosis; for this reason simple catarrhal icterus should not be diagnosticated, until a careful examination has excluded such possibilities.

Epidemics of jaundice have been recorded in various portions of the world, in which the disease ran its usual course in men and nonpregnant women, but was disastrous in pregnancy, some of the women dying in coma and many more aborting or falling into labor prematurely. Moreover, it would seem that pregnancy sometimes predisposes to the occurrence of jaundice, as Van der Velde and others have recorded instances in which it occurred in successive pregnancies and was frequently associated with hemoglobinuria.

It is generally believed that women suffering from jaundice at the time of labor have a tendency to hemorrhage, but this was not noted in the few cases which I have seen.

Gallstones.—The fact that cholelithiasis occurs more frequently in women than in men would suggest a possible association with the increase in the amount of cholesterin in the blood which characterizes pregnancy. Acute attacks may occur during pregnancy or the puerperium, and Peterson, in 1910, collected 25 operations performed in the former, and 10 in the latter period. It is always a serious complication, and operation, if urgently demanded, should be undertaken without regard to the existence of pregnancy. In less urgent cases it is, of course, advisable to postpone interference until after the child has become viable.

Acute Atrophy of the Liver.—This condition will be considered in the chapter on the Toxemias of Pregnancy.

Indigestion.—Pregnant women frequently suffer from indigestion, and the symptoms arising from it are sometimes very distressing. Kehrer is inclined to attribute them, at least in part, to the decrease in the amount of gastric hydrochloric acid, which he considers usual in pregnancy. Such cases should be treated without reference to the existence of pregnancy. In many instances marked relief follows the administration of a wineglass of cream a half hour before each meal.

Constipation.—Owing to distention by the growing uterus, the abdominal walls may become so impaired in tonicity that considerable difficulty is experienced in evacuating the bowels. Indeed, it may be said that the majority of pregnant women suffer from constipation. This condition should be carefully guarded against in order to avoid auto-intoxication and increased strain upon the kidneys. It is best overcome by appropriate diet, regularity in going to stool, and the occasional use of pills of aloin, belladonna, and strychnine, the fluid extract of cascara, or compound licorice powder. Mineral oil by itself does not give satisfactory results, but when taken in combination with the milder laxatives, it enables one to decrease the dose of the latter. The stronger cathartics should be avoided on account of their tendency to cause abortion.

Enteroptosis.—The neurasthenoid symptoms which so frequently accompany enteroptosis are often markedly ameliorated during pregnancy, inasmuch as the steadily enlarging uterus may tend to restore the displaced viscera to their normal positions. The comfort of the patient can be added to appreciably by the use of rational clothing, and especially by the application of a properly adjusted abdominal supporter. The condition, however, is prone to recur after childbirth unless the patient takes on considerable flesh. According to Maillart the improvement is sometimes permanent, especially if the relaxation of the abdominal walls be counteracted by the use of a snugly fitting binder during the puerperium and a suitable abdominal supporter afterward.

Salivation.—In exceptional instances the salivary secretion becomes markedly increased during pregnancy. As a rule, this is not a serious complication, but now and again the amount of saliva is so great as to cause the patient great annoyance, and sometimes even prevent her from sleeping. One of my own patients expectorated between 500 and 600 cubic centimeters of clear fluid every day for several weeks, while Lvoff has reported several cases in which the secretion in the twenty-four hours varied from 1000 to 1600 cubic centimeters.

The condition is usually attributed to a reflex neurosis incident to pregnancy, but sometimes it is a manifestation of toxemia. In the first class of cases the treatment is very unsatisfactory, astringent mouth washes, and even comparatively large doses of atropine, being without effect. On the other hand, when the condition is a manifestation of toxemia, prompt amelioration may follow the use of a rigorous milk diet.

It sometimes happens that the cloudy fluid which is supposed to be saliva, in reality represents regurgitated gastric secretion. My assistant, John G. Murray, Jr., had under his care a patient apparently suffering from salivation, and who was daily excreting nearly a liter of fluid. Chemical examination in our laboratory revealed the surprising fact that the fluid presented an acid reaction, which was due to the presence of hydrochloric acid in the same proportion as in gastric juice. How frequent such an occurrence may be can only be determined by future investigation.

Gingivitis.—Exceptionally, the gums of pregnant women become inflamed and spongy, and bleed upon the slightest touch. The condition is usually observed in run-down individuals, and is very refractory to treatment, although in many cases it disappears almost immediately after delivery. It is best met by the employment of astringent mouth washes, especially those containing tincture of myrrh, combined with general tonic treatment and an abundant diet.

Dental Caries.—Many women suffer during pregnancy from dental caries, which may be associated with more or less severe toothache. It is a popular belief that pregnancy predisposes to the condition, as is evidenced by the saying, "For every child a tooth." It is probable that the condition is somewhat allied to the minor degrees of osteomalacia which occur only during pregnancy. Such patients should be referred to a skillful dentist, and at the same time should drink considerable quantities of milk, and take calcium chloride.

Diseases of the Kidneys and Urinary Tract.—*Chronic Nephritis.*—Pregnancy occurring in patients suffering from chronic nephritis is always a serious complication, and will be considered in the chapter on the Toxemias of Pregnancy.

Glycosuria and Diabetes.—Blot, in 1856, stated that sugar could usually be found in the urine of lactating women; but after it had been demonstrated that the condition was a lactosuria, the belief gained ground that the existence of true diabetes was inconsistent with conception. This view was first combated in 1882 by Matthews Duncan, who was able to find in the literature 22 cases in which pregnancy was complicated by diabetes, and he laid down the dictum, which received general acceptance, that such an association was extraordinarily serious.

True diabetes is rarely noted in pregnant women, and may exist before the inception of pregnancy, or may occur during its course. The prognosis is generally believed to be ominous for mother and child. In the 66 cases which I collected in 1909, 27 per cent of the mothers died at the time of labor or within two weeks afterward, while an additional 23 per cent perished during the following two years. Moreover, about one-eighth of the pregnancies ended in abortion or premature labor, and one-third of the children going to term were born dead. Such statistics give too gloomy a picture, as they are based mostly upon severe cases, and do not take into account the milder ones, which are usually not reported. Lambie takes a similar view, and considers that many serious cases can be carried safely through pregnancy, particularly with the judicious administration of insulin.

Stander and Peckham have described three patients from our clinic, who safely went through repeated pregnancies after the development of diabetes. In several of them, as well as in other cases in our service, the glycosuria disappeared spontaneously during the second half of pregnancy, even when on ordinary diet, to reappear some weeks after delivery. Such an occurrence might plausibly be explained by the theory of Carlson that the pancreas of the fœtus had temporarily compensated for the lack of insulin on the part of the mother; although many experimenters deny the validity of his observations. However that may be, the fact remains that many diabetics do extraordinarily well during pregnancy, while others do so badly, even with the help of insulin, that the propriety of interrupting the pregnancy must be seriously considered.

Leipmann has stated that diabetic women are particularly prone to infection at the time of labor, and that gangrenous processes may occur in the uterus, in the form of metritis dissecans, just as are sometimes noted in other portions of the body in nonpregnant individuals.

In many instances, the child attains excessive size, which Lambie attributes to the unusual amounts of sugar brought to the placenta by the maternal blood. Likewise it is interesting to note that hydramnios is a frequent complication, and in 5 of the 7 cases collected by Graefe sugar could be demonstrated in the liquor amnii. According to Rossa, Ludwig, and Offergeld, such an occurrence may be regarded as affording presumptive evidence that the amniotic fluid is a maternal transudate, since no trace of sugar could be detected in the fœtal urine.

On the other hand, too much emphasis cannot be laid upon the fact that the mere demonstration of sugar in the urine does not justify the diagnosis of diabetes with its serious prognosis. With the ordinary Fehling test, I obtained a distinctive reaction for sugar in about 5 per cent of all women in the last months of pregnancy. Ordinarily this is due to lactosuria and is of no clinical significance. If more accurate chemical methods be used, sugar can be detected much more frequently, and Commandeur and Porcher state that traces occur at some time in the course of every pregnancy. They found glucose or lactose in 20 and 80 per cent of their cases, respectively, and occasionally both varieties together.

About once in every 100 to 150 pregnant women a nondiabetic glycosuria may be observed, and may even recur in succeeding pregnancies. The amount of sugar is always slight, varying from 0.25 to 2 or 3 per cent, disappears spontaneously after delivery and apparently does no harm. In such cases we usually have to deal with alimentary glycosuria or with one due to a lowering of the renal threshold for sugar. Payer and others have shown that pregnant women are less tolerant of sugar during pregnancy than at other times, as he was able to produce alimentary glycosuria in 80 per cent of his patients by increasing the amount of sugar ingested. Commandeur and Porcher hold that the condition is due to the inability of the nonfunctioning breasts to convert glucose into lactose, as normally occurs during lactation; while Hofbauer believes that it is dependent upon hepatic insufficiency, which he considers is an exaggeration of the fatty changes at the periphery of the liver lobules, which he has described as a concomitant of normal pregnancy. Benthin, however, is inclined to believe that it should be attributed to alterations in function of some of the ductless glands—the pituitary, according to Wallis and Bose.

Novak, Porges and Strisower, in 1913, advanced the view that in certain cases the glycosuria of pregnancy is due to increased permeability of the kidneys and not to any perversion in the carbohydrate metabolism. Küstner, and Wallis and Bose share this opinion, and the former holds that whenever glucose is present in the urine, while the blood sugar content is less than 200 milligrams, the condition must be considered as renal in origin. Consequently, glycosuria of this character is in no way related to diabetes, but represents a temporary phenomenon incident to pregnancy, and Küstner considers that he has adduced experimental evidence that it is in some way associated with the ovarian function.

Due to the frequent occurrence of lactosuria, the first essential, following a positive reaction with Fehling's solution, is to determine by the fermentation test or the polariscope whether lactose or glucose is present; if the former, no anxiety need be felt, as lactosuria is a physiological phenomenon. On the other hand, if glucose is present, the matter is not so simple, as it is often difficult to determine whether it is a manifestation of true diabetes or merely of an alimentary, renal, or recurrent glycosuria.

The former should be diagnosticated if it is found that the condition existed prior to pregnancy, or if large amounts of glucose are demonstrable in the blood, but more particularly if the characteristic symptoms of thirst, emaciation, dyspnea and acetonuria are present. A probable diagnosis of alimentary glycosuria is permissible if the glycosuria disappears upon simple regulation of the diet; while renal glycosuria should be diagnosticated if examination of the blood demonstrates the absence of hyperglycemia. In the latter type of cases, the mild glycosuria occasionally persists notwithstanding a rigorous regimen, but the patients usually go through pregnancy and labor without difficulty and the condition disappears early in the puerperium. True diabetes, on the contrary, should always be regarded as a serious complication. The urine should be examined daily, and if the loss of sugar cannot be controlled by simple means, the aid of a skilled internist should be sought, as it appears that during pregnancy the ketogenic-antiketogenic balance is more difficult to maintain than at other times, even with the help of insulin. In general, the prognosis is better in women over thirty years of age than in young primiparæ, as it has been only in the latter that I thought the interruption of pregnancy advisable, and even then death sometimes followed. Full literature upon the subject up to 1926 will be found in Lambie's comprehensive article.

Hematuria.—The passage of bloody urine is rarely observed during pregnancy, therefore its occurrence should always lead one to suspect and search for a serious lesion of the urinary tract. Nevertheless, Chiaventone has described an idiopathic hematuria due to pregnancy, and has collected 18 similar cases from a literature. He considers that the hemorrhage is probably due to histological changes in the kidney which result from a toxemia. In the absence of a more serious lesion, the bloody urine may be due to the presence of varicose veins in the wall of the bladder.

Pyelitis and Pyelonephrosis.—According to Vinay, attention was first called to this complication of pregnancy by Reblaud, in 1892. Opitz, in 1905, collected 84 cases, and since then an immense literature has accumulated upon the subject.

The disease usually appears in the latter half of pregnancy, when the patient, who had previously been well, or had merely complained of slight vesical irritation, is suddenly seized with intense paroxysmal pains, usually in the right renal region. This is accompanied by a marked elevation of temperature and occasionally by chills, the temperature sometimes running a hectic course. Urinary examination reveals the presence of pus cells and usually of colon bacilli. If the process goes on to the development of a pyelonephrosis, palpation shows that the affected kidney is definitely enlarged. In this event, the pain may disappear and the kidney become suddenly smaller after the passage of a large amount of purulent urine, the symptoms reappearing as the kidney fills again. If this condition is neglected, the patient may succumb to a septic process.

Pyelitis is always due to bacterial infection, which is facilitated by the decreased resistance resulting from distention of the ureters. The bacterial invasion may be due to an extension upward from the bladder, or to transmission of bacteria through the blood or lymph channels, or from the intestines. Bacillus coli is the usual infecting agent, but the streptococcus, gonococcus, or tubercle bacillus is sometimes concerned. Formerly it was thought that the predisposing factor consisted in compression of the ureter at the brim of the pelvis by the pregnant uterus, with damming back of urine. Hofbauer, in our clinic, however, showed that this is not usually the case, as the x-ray shows that the distention begins lower down, and usually just distal to the bladder. He then showed that the musculature of the base of the bladder, as well as that of the juxtavesical portion of the ureters, partakes of the hypertrophy which characterizes pregnancy. As a result, the lumen of the lowermost part of the ureters becomes constricted, while the part above undergoes dilatation, with consequent decreased resistance to bacterial invasion. In other words, all pregnant women are predisposed to the development of pyelitis.

Ordinarily pain in one lumbar region, the palpation of the enlarged and tender kidney and the characteristic urinary findings, as well as the occasional detection of the enlarged and sensitive ureter on vaginal examination, should make the diagnosis clear. Yet the condition is frequently mistaken for appendicitis and occasionally for typhoid fever or salpingitis. The treatment consists of rest in bed and an abundant but bland diet, together with large quantities of water and milk, and enough sodium bicarbonate to convert the urinary reaction from acid to alkaline. For this purpose 30 grains, administered every four hours, is usually sufficient, but occasionally larger doses may be necessary. In my experience better results are obtained in this way than by the use of hexamethylenamine, which was formerly extensively employed. Ordinarily improvement is rapid, but in the rare cases in which it does not occur, premature labor should be induced without hesitation, as the involution which follows removes the ureteral obstruction and allows of free drainage from the kidney into the bladder, the establishment of which, as a rule, is followed by rapid recovery. Unfortunately, the cure is frequently only symptomatic, as in somewhat less than one-half of the cases ureteral catheterization a year after delivery reveals the existence of a chronic process, which frequently flares up in a subsequent pregnancy. Such observations suggest the possibility that the process had antedated the pregnancy, and sometimes it may be regarded as the continuation of a process which had originated in childhood. Klaften, in 1924, reported that only 16 out of 33 cases, which he had followed up, had resulted in complete cure, and my experience is in accord with his observations. In the acute cases irrigation of the bladder, the ureters, or renal pelves is rarely necessary. Occasionally, in cases of pyelonephritis, the process may continue after emptying the uterus, and necessitate nephrotomy or even removal of the kidney. Each year, I see many patients with pyelitis, and the great majority are promptly relieved of their symptoms by the simple treatment outlined above; but unfortunately prolonged treatment after delivery is sometimes necessary to effect a complete cure; and occasionally the induction of premature labor is necessary. In two neglected cases death occurred from a general septic process, due in one instance to the streptococcus, in the other to the gonococcus.

Floating Kidney.—The symptoms arising from a movable or floating kidney are usually considerably alleviated during pregnancy, as the enlarged uterus tends to retain the organ in its normal situation. In rare instances, however, the pedicle of the kidney may become twisted and give rise to intense pain, which may be mistaken for renal colic or appendicitis. Careful taxis will usually suffice for reduction, after which the symptoms at once disappear.

Owing to the increased laxity of the abdominal wall following childbirth, the symptoms are apt to become aggravated when the patient gets about, unless she has taken on considerable flesh, so that sufficient fat has formed about the kidney to hold it in place. A snugly applied bandage should be worn through the puerperium.

Dislocation of the Kidney.—Cragin has reported an instance in which a congenitally displaced kidney, occupying the pelvic cavity, led to symptoms of incarceration, necessitating its removal. He collected five somewhat similar cases, while Stephans collected the literature upon the subject up to 1912. The condition usually escapes recognition until it gives rise to dystocia, but in one of our cases, in which the condition had been discovered at a previous laparotomy, the displaced organ was gradually pushed out of the pelvic cavity by the enlarging uterus, so that easy spontaneous labor occurred.

Pregnancy after Removal of Kidney.—With the extension of renal surgery it is not uncommon to have to consider what may be the outcome in women who have become pregnant after the removal of one kidney on account of tuberculosis, pyelonephritis or other lesions. Bleynie, in 1910, collected 35 such cases from the literature, while eleven years later Matthews studied 265 labors occurring in 241 nephrectomized women, and I see several such cases each year.

Owing to the fact that the potential renal function is much in excess of the needs of the individual, such women do perfectly well provided the remaining kidney is normal. On the other hand, if it is the seat of chronic nephritis irreparable damage may result from the additional strain incident to pregnancy; while the development of a toxemia must be regarded as much more serious than in a patient with two kidneys. Accordingly, in the absence of symptoms, such patients should be carefully watched, and each month accurate chemical and functional tests should be made in order to make sure that the single kidney is functioning satisfactorily, which is fortunately the case in most instances, when spontaneous labor occurs at term. Of the 265 labors reported by Matthews 250 were spontaneous and only two of the patients died. On the other hand, if the patient is suffering from chronic nephritis, abortion should be induced as soon as the diagnosis is made, and followed by a sterilizing operation unless the patient is coöperative enough to make intelligent use of contraceptive means. Moreover, premature labor should be induced at the first sign of the development of a toxemia.

Cystitis.—Pregnancy is occasionally complicated by cystitis, which is usually due to gonorrheal infection, though the colon bacillus may be the infective agent. In view of the possibility of an ascending pyelitis and a resulting pyelonephritis, the condition demands prompt treatment.

Floating Spleen.—Occasionally an enlarged spleen occupying the lower abdomen may be mistaken for the pregnant uterus. If pregnancy supervenes, it is usually uninfluenced by the floating organ, which is gradually forced into its normal position as the uterus enlarges. Occasionally, however, pronounced peritonitic symptoms may appear as the result of torsion of its pedicle, when splenectomy will be indicated. The literature upon the subject up to 1907 has been well reviewed by Heil.

Diseases of the Nervous System.—*Paralysis.*—Paralysis of central origin sometimes occurs during pregnancy, and is generally associated with toxemic or septic processes. Thus, in the toxemias of pregnancy and eclampsia, serious disturbances may follow edema of the brain or apoplexy. In infectious processes thrombosis may occur in the cerebral vessels, and occasionally emboli may cut off the circulation of large areas of the brain and lead to various paralyses and even to death.

Paraplegia of spinal origin occasionally occurs, but, except in rare cases of toxemia, is not directly dependent upon the existence of pregnancy. It does not appear that spinal paraplegias interfere with conception, as women suffering from them frequently become pregnant. In this event, as well as in women with advanced tabes dorsalis, the course of pregnancy is usually uncomplicated and the labor easy and comparatively painless.

Neuralgia.—Neuralgic pains are frequent concomitants of pregnancy. In rare instances they are very obstinate and resist all treatment, though they often disappear spontaneously after labor. During the later months of pregnancy the head of the child, after descending into the pelvis, may compress one or other sciatic nerve and give rise to severe pain along its course, which is sometimes accompanied by intense muscular spasm. Owing to its mode of origin, this form of sciatica is not amenable to treatment.

Neuritis.—Whitfield, Eulenberg, and others have directed attention to an idiopathic neuritis which occurs during pregnancy. Many cases are associated with toxemic vomiting of pregnancy, and it occasionally follows other toxemic processes. For this reason, the neuritis is supposed to be due to toxic influences and not to be brought about by pressure upon the nerves involved. It usually disappears spontaneously, but slowly, after childbirth. The affection may be limited to a single nerve, or may appear as a multiple neuritis. It is characterized by paralysis of the affected region associated with muscular atrophy and the presence of the characteristic reaction of degeneration. There is marked sensitiveness along the course of the affected nerves, which is frequently associated with shooting pains. Sensibility of the parts is markedly impaired, and the patients frequently suffer from paresthesiæ. Occasionally the symptoms are so severe that the indication of abortion or premature labor may be justifiable.

Chorea.—Pregnancy occasionally occurs in choreic individuals, while in rare instances the disease does not appear until after conception. In the first class of cases it is comparatively unimportant, while in the latter the choreic movements are sometimes so intense as to interfere with sleeping or the taking of food. In these cases of chorea gravis the patient becomes maniacal, and may abort spontaneously. In somewhat over one-third of the cases the outbreak of the disease has been preceded by rheumatic fever and heart disease. The appearance of fever is of serious import, and at autopsy evidences of malignant endocarditis were found in over 86 per cent of the cases. Apart from meningeal exudates the lesions noted in the central nervous system were variable.

The disease has been exhaustingly studied by Buist in 1892, by Pineles in 1913, and by Willson in 1929, who collected 255, 426, and 906 cases, respectively. According to Willson, chorea is preëminently a disease of young women, the average age in his tabulation being 22.4 years. With more rational treatment the mortality has slowly fallen from 25 to 30 per cent in the early reports to 14 per cent in Willson's series. The latter points out that the prognosis depends in great part upon the time at which the chorea first appears, there being no mortality when the onset preceded pregnancy, while it increased from 14.8 to

16, and to 20.7 per cent according as it appeared in first, second, or third trimester of pregnancy.

Many patients do very well upon simple medicinal treatment, the disease disappearing before delivery. On the other hand, the febrile cases do extremely badly no matter what is done. Willson believes that the induction of abortion is unnecessary in the milder cases, and does no good in the severe ones. This coincides with my experience, as of the two cases of chorea gravis which I have seen, one died after spontaneous premature labor, and the other after induction of abortion.

Albrecht holds that the condition is usually toxemic in origin, and reports that cure promptly follows the intravenous injection of 20 cubic centimeters of blood serum obtained from a normal pregnant woman. This may be possible in certain mild cases, but cannot apply to the severe ones in which the onset was preceded by rheumatic fever, and autopsy showed acute endocarditis and meningitis.

Epilepsy.—This disease appears to have no effect upon pregnancy, though at the time of labor it may be mistaken for eclampsia by inexperienced observers. If the attacks are frequent, the patient should be put upon large doses of potassium bromide and treated just as at other times. As a rule, it is not advisable to allow the mother to nurse her child, as lactation sometimes appears to aggravate the disease, while serious injury might possibly be done to the child during an attack. On the other hand, in occasional instances the mentality of the patient appears to undergo progressive deterioration with each succeeding pregnancy. In such circumstances, pregnancy should not be interrupted, but the advisability of sterilization after delivery should be considered.

Hysteria.—Hysteria is a not infrequent complication of pregnancy, but does not appear to exert a deleterious influence upon its course. Indeed, the physical condition often undergoes marked improvement at such times. Occasionally, however, the hysterical symptoms may become aggravated. Many authors have of late been inclined to attribute the nausea and vomiting of pregnancy to a neurosis, which, in my experience, is the dominating factor in most cases, but it cannot be regarded as the sole cause of the condition.

Tetany.—In rare instances tetany may occur during the course of pregnancy, Meinert, in 1898, being able to collect 20 cases from the literature. In some patients the disease appears only during pregnancy and is absent at other times. H. M. Thomas reported a case in which the condition had appeared in 6 successive pregnancies, and gave a full *résumé* of the literature up to 1895.

Formerly tetany was thought to be connected in some way with abnormalities of the thyroid gland, as it sometimes occurred after the removal of that organ. Following the experimental work of Frommer, and Adler and Thaler, which was well reviewed by Seitz in 1913, it has been shown to be due to the absence or imperfect secretion of the parathyroid bodies, as it has been demonstrated that portions of the parathyroids could be removed from white rats without effect, but that symptoms of tetany would appear whenever the animals became pregnant.

Kehrer reports that excellent results follow the administration of calcium chloride, just as in nonpregnant persons.

Goiter.—We have already referred to the slight enlargement which the thyroid normally undergoes during pregnancy. Bignami has reported a case, which in his opinion, proved that pregnancy occasionally exerts a pathological influence upon this gland. During his patient's first pregnancy the thyroid underwent considerable hypertrophy, but returned to its normal size after delivery. The condition returned in the second pregnancy, the enlargement reaching such proportions that death resulted from suffocation.

While moderate degrees of exophthalmic goiter occur relatively frequently in women, there is little evidence that pregnancy plays any part in its production. Mussey, Plummer and Boothby reported in 1926 that pregnancy existed in 42 out of a series of 4185 women of forty years of age or less, who were treated at the Mayo Clinic for exophthalmic goiter, and stated that in general pregnancy had little influence on the goiter, and vice versa. Furthermore, they stated that pregnant women stood thyroid operations well, and that there was little indication for interrupting the pregnancy. On the other hand, Seitz stated that in 60 per cent of the 112 cases which he collected from the literature, pregnancy led to exacerbation of the symptoms, with a fatal issue in 7 cases. He held that serious consequences are to be apprehended especially when the condition is associated with a persistent thymus, and when death occurs it is usually due to circulatory conditions or to a general intoxication. The child is but little affected, although there is some evidence to indicate that the tendency toward spontaneous premature labor is increased.

Formerly, the induction of premature labor was recommended whenever the symptoms became urgent, but with increasing surgical knowledge prompt operation upon the thyroid seems preferable.

In several of my patients the tachycardia was considerably exaggerated during the latter part of pregnancy, but became less marked after delivery. In none, however, were the symptoms sufficient to justify terminating the pregnancy.

Addison's Disease.—Very rarely pregnancy may occur in women suffering from this disease, or it may first become manifest after the onset of pregnancy. In either event it is a very serious complication. Fitz-Patrick, who has collected 12 cases from the literature, reports that five of the women died before delivery, but in those who survived pregnancy and labor appeared to have had no effect upon the underlying disease.

Disturbances of Vision.—Disturbances of vision are rarely observed during pregnancy, but inquiries should always be made and the patient cautioned concerning their diagnostic significance if they appear. Amaurosis or total blindness occurring at this time is generally due to albuminuric retinitis, and the first indication of a serious renal affection is sometimes afforded by an ophthalmoscopic examination.

Diseases of the Blood.—*Pernicious Anemia.*—According to Osler, this complication was first described by Channing in 1842. Since then a considerable literature has accumulated upon the subject, which is well reviewed in the articles of Esch, Adler, Larrabee, Schneider and Pohl. The general consensus of opinion is that the form occurring in pregnant and puerperal women is not true pernicious anemia, but rather a hemolytic variety resulting from the destruction of red blood cells by suppositious toxins arising from the chorionic epithelium. This conclusion is based upon the fact that most patients recover if properly treated, in contrast to the almost uniformly fatal issue in true pernicious anemia.

The disease may appear during pregnancy, but in many cases it is not recognized until after labor. It is characterized by marked pallor and anemia, which are associated with weakness and shortness of breath, the extremities also becoming edematous. A positive diagnosis is made by the microscopical examination of the blood, when the number of red blood cells is found to be markedly diminished. Many of the corpuscles are irregular in shape, while nucleated varieties are not infrequently observed. At the same time there is a relative increase in the amount of hemoglobin, though its total amount is considerably below normal.

Formerly, the disease usually ended in death, when marked fatty degeneration of the various organs is found at autopsy. Fowler's solution administered in increasing doses, beginning with 5 drops three times a day, sometimes does good, but the main reliance should be placed upon liver diet and frequent blood transfusions. When occurring during pregnancy, interruption should be considered only if the condition of the patient becomes alarming; but in such cases the rapid improvement following delivery is very striking, as illustrated by the case reported by Pohl, as well as in one of my own patients.

Leukemia.—Leukemia is a very rare complication of pregnancy, Hermann and H. Schroeder being able to collect from literature only 8 and 10 examples, respectively. In 4 cases the disease had existed before the onset of pregnancy, while in the remainder it appeared after its inception. It exerts no direct effect upon gestation, though the association of the two conditions may seriously affect the mother. In several instances premature labor resulted, after which the symptoms underwent marked amelioration.

The diagnosis is rendered probable by the existence of marked anemia associated with enlargement of the spleen, and is placed beyond doubt by a differential blood count. Examination of the fœtal blood indicates that the characteristic leukocytes are not transmitted to the fœtus. In view of the good results which sometimes follow spontaneous premature labor, pregnancy may be terminated artificially in serious cases.

Purpura Hæmorrhagica.—Forty-eight cases of this rare and accidental complication of pregnancy were reported up to 1926 in the reviews of Rushmore, and Liebling, and I have seen one case. It usually occurs in the second half of pregnancy, and is extraordinarily dangerous, as death occurred in 60 per cent of the cases reported. In several instances it is said to have recurred in succeeding pregnancies. The treatment is symptomatic, unless one is prepared to extirpate the spleen.

Lead Poisoning.—C. Paul studied the histories of 141 pregnancies occurring in women suffering from chronic lead poisoning, and found that 86 ended in abortion or premature labor. Moreover, a large number of the children which were born alive perished at an early period, only 10 per cent remaining alive at the tenth year. There is no doubt that the lead is transmitted through the placenta, as in a premature child examined by Lewin 16 per cent of the total weight of the liver was due to it. Frongea states that lead poisoning not only leads to abortion or premature labor, but is a potent cause of sterility; as in the lead works of Sardinia 20 per cent of the married women are sterile, and an additional 23 per cent have only one child.

Experiments reported by Weller, in 1915, indicate that the deleterious effect of lead poisoning may be traced to either parent. He found that sterility was common when normal female guinea-pigs were mated with males suffering from chronic lead poisoning, and when pregnancy resulted the young were subnormal in weight and exhibited an increased mortality after birth. Likewise, when normal males were united with poisoned females, stillbirths occurred very frequently, and the living offspring were undersized. In the light of his experiments, Weller believes that lead exerts a direct unfavorable influence upon the sperm cells and the early ova.

Diseases of the Skin.—*Impetigo Herpetiformis.*—Hebra was the first to call attention to the serious nature of this disease, which occurs almost exclusively in pregnant or puerperal women, and is characterized by superficial pustules, which are arranged in groups or clusters with inflammatory bases. New lesions appear on the borders of older and crusted confluent patches, while recovery takes place in their centers. The lesions occur on the trunk, thighs, and in the neighborhood of the genitalia, but rarely upon the face. They are accompanied by itching and constitutional symptoms, chills and high fever. The recorded mortality is about 75 per cent, Debreuihl having collected 24 cases with 18 deaths. The disease, as a rule, does not lead to abortion or premature labor, and many of the women affected with it died undelivered. According to Scheuer, it is toxemic and not bacterial in origin. The treatment is purely palliative, but in view of the serious prognosis it may be advisable to adopt Mayer's suggestion and inject into a vein small quantities of blood serum obtained from normal pregnant women.

Herpes Gestationis.—This disease, more frequently known as dermatitis herpetiformis, is an inflammatory, superficially seated, multiform, herpetiform eruption, which is characterized by erythematous, vesicular, pustular, and bullous lesions. It occurs occasionally in pregnant women, and is accompanied by marked burning and itching. It pursues a chronic course, is often attended with fever, and sometimes may even end in death.

Dühring believes that it is probably toxemic in origin, though similar lesions sometimes occur during the course of sepsis. In view of its depressing character, the patient should be placed upon tonic treatment, while the itching is best allayed by the use of ointments or lotions containing oil of cade, carbolic acid, or simiiar substances.

Pruritus.—Itching may occasionally be a distressing complication. It may extend over the greater part of the body or be limited to the genitalia. General pruritus should be regarded as a neurosis, which is probably toxemic in origin. It often gives rise to intense suffering, the itching sometimes being so constant that the patient is unable to sleep. In some patients the loss of rest and the nervous strain attendant upon it exert a marked influence upon the general condition. Such cases are best controlled by the administration of sedatives and general tonic treatment. A rigid milk diet is sometimes followed by excellent results. When the condition is not amenable to treatment and the patient shows objective signs of exhaustion, the termination of pregnancy may be justifiable.

Genital pruritus—*pruritus vulvæ*—may be due to several causes, among which are irritating vaginal discharges, parasites or glycosuria. When due to the first-named cause, the condition is best treated by the administration of astringent vaginal douches and the maintenance of absolute cleanliness. At the same time the itching may be allayed by the employment of ointment containing cocaine, menthol, or carbolic acid. Pruritus of diabetic origin is observed but rarely, but the possibility of its occurrence should always be borne in mind and the urine examined. If sugar is present, relief can be obtained only by placing the patient upon a suitable diet, while at the same time appropriate ointments should be employed. Occasionally intense itching about the anus may be due to the presence of seatworms, which are best destroyed by the use of rectal enemata of infusion of quassia. If local measures prove ineffectual, a dose of 5 grains of santonin at night, followed by Rochelle salts the next morning, will often bring about the desired result.

Abnormalities of Pigmentation.—During pregnancy abnormalities in pigmentation are frequently noted, which are particularly marked along the linea alba and about the breasts. In other cases unsightly, more or less symmetrical yellowish splotches—*cloasma*—appear upon the face. They are not amenable to treatment, but usually disappear promptly after childbirth.

Hematoma of the Abdominal Walls.—Stoeckel has reported two cases of hematoma of the abdominal walls occurring during pregnancy. In one case the tumor was situated in the sheath of the right rectus muscle just above the symphysis, while in the other it appeared as a large mass in the right hypogastric region, and was mistaken for the head of the child. The condition resulted from rupture of the inferior and superior epigastric arteries respectively.

Relaxation of the Pelvic Joints.—Owing to the great vascularity incident to pregnancy, the various pelvic joints always show a somewhat increased motility. Occasionally, however, the softening of the interarticular cartilage at the symphysis pubis admits of such abnormal motion in the joint as to interfere seriously with the comfort of the patient, who suffers from intense dragging pains in the pelvis and lower abdomen; while at the same time the gait may be so profoundly altered as to suggest the existence of cerebral or spinal trouble. In such cases the application of a tightly fitting bandage about the thighs is followed by marked improvement, though occasionally the symptoms are so pronounced that the patient is obliged to take to her bed. The condition usually disappears spontaneously during the course of the puerperium, but in exceptional instances it may persist and give rise to such great discomfort that it may become necessary to "wire" the joint.

Similar relaxation may involve the sacro-iliac joints and cause great suffering. Particular attention has been directed to its frequency and significance by Goldthwait and Osgood. In many instances great relief may be afforded by applying adhesive strips, which extend outward from the posterior surface of the sacrum to the external portion of the thighs.

Accidents during Pregnancy.—The pregnant woman is exposed to the same possibility of injury as at other times. Prognosis is not altered except that abortion or premature labor often occur. Pregnancy itself may be complicated by accidents which are incident to that condition, the most important being rupture of an extra-uterine pregnancy, rupture of the uterus, and premature separation of the placenta—all very serious complications. Their mode of production and treatment will be considered in detail in the appropriate chapters.

Surgical Operations during Pregnancy.—Formerly it was believed that the performance of surgical operations during pregnancy would almost inevitably bring about abortion or premature labor, even the extraction of a tooth being considered a serious procedure. At present, however, thanks to anesthesia and a perfected surgical technic, many operations can be performed at this time with but little additional risk. Accordingly, whenever a condition arises in the pregnant woman which imperatively demands surgical treatment, the necessary operation should be performed without hesitation. At the same time, if the indication is not pressing, it is advisable to defer interference until after delivery, so as not to subject the patient to an added strain.

A review of the literature goes to show that amputations are not more dangerous than at other times. Schmidt, in 1915, collected from the literature thirty-six cases in which nephrectomy was performed, and had no effect upon the course of pregnancy in twenty-eight instances. Furthermore, numerous cases are on record in which paranephritic or broad-ligament abscesses have been opened. Tumors of the generative tract can likewise be excised without great risk or markedly increasing the danger of premature labor, and are considered in the chapter on Complications Due to Disease of the Generative Tract.

Appendicitis.—Appendicitis probably occurs as frequently during pregnancy as at other times, but until recently it was usually overlooked. Jerlov was able to collect 456 cases which had occurred in Scandinavia in the twenty years following 1900.

It should be regarded as a serious complication, as many women die if not operated upon, while the surgical procedures undertaken for its relief are frequently followed by premature labor. Pankow attributes its increased gravity at this time to the fact that the head of the cæcum is displaced upward as pregnancy advances, being on the level of the iliac crest in the latter part of gestation, instead of at the level of the acetabulum as in nonpregnant women.

Pregnancy does not predispose to its occurrence, but in cases of chronic disease, in which the appendix has become adherent to the appendages or uterus, exacerbation may result from the traction exerted by the enlarging organ. Moreover, when the process has eventuated in abscess formation, the rapid decrease in the size of the uterus following delivery may readily bring about rupture of the abscess walls.

The symptoms do not differ from those observed in nonpregnant women, but the condition is frequently not recognized, as the pains are often considered as being due to the pregnancy itself, while the distention of the abdominal walls by the enlarged uterus makes difficult the appreciation of the rigidity and muscle-spasm, which are usually valuable diagnostic aids.

One should always consider the possibility of appendicitis when a pregnant woman complains of pain in the right side of the abdomen, associated with an elevation of temperature and pulse, provided some more satisfactory explanation for the condition cannot be found. It should, however, be remembered that pyelitis or inflammatory conditions of the appendages may give rise to identical symptoms. At the time of labor and during the puerperium its recognition is still more difficult, and many women have died from perforative peritonitis with the diagnosis of puerperal infection.

Operation is indicated in all cases in the early months, as abortion is not likely to occur unless the uterus is subjected to much manipulation. Later in pregnancy the presence of the enlarged uterus renders it difficult to expose the parts satisfactorily, and may seriously interfere with proper drainage should it prove necessary. In view of this difficulty, it is suggested that the uterus be emptied by cesarean section before attacking the appendix. I, however, do not believe that this is always necessary, and am convinced that its general adoption will add to the gravity of the operation. In the latter months spontaneous premature labor is frequently observed, particularly in cases of abscess formation. It may be due to one of several factors—manipulation of the uterus, fever, and, when an abscess has formed, to the direct transmission of bacteria from it to the fœtus.

Intestinal Obstruction.—This rare complication of pregnancy should be treated upon general surgical principles. I have seen two cases. In the first intussusception occurred at the site of a tubercular ulcer, and death followed resection of the gut; while in the second case obstruction was due to constriction by a peritoneal adhesion in a case of tubercular peritonitis. This was relieved by operation, and the patient was delivered at term, but died some weeks later from miliary tuberculosis.

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CHAPTER XXVI

THE TOXEMIAS OF PREGNANCY

Fortunately, in the great majority of cases gestation pursues a physiological course and is not attended by untoward symptoms. At the same time, there is no other condition in which the borderline between health and disease is less sharply marked, since a very slight irregularity often suffices to convert a physiological and normal into a pathological and abnormal state.

The general metabolism becomes profoundly modified during gestation, as is shown by the fact that during its later months the pregnant woman stores up nitrogen and water to a far greater extent than at other times, so that it would appear that her internal "housekeeping" is conducted upon much more economical lines than formerly. Although it is generally held that the excretory functions are more liable to serious derangement, since they are called upon to care for the elimination of increased quantities of waste products derived from the fœtal, as well as from the maternal organism, no evidence is available in support of such a view. On the contrary, analysis of the urine shows that during the last weeks of pregnancy the woman eliminates less nitrogen than at other times, and it has not been demonstrated that the so-called toxemic disturbances of pregnancy are primarily dependent upon overworked kidneys, unless those organs were already insufficient when conception occurred.

Doubtless, the metabolic changes which characterize normal pregnancy and continue for some time after delivery, result from functional organic alterations with which we are as yet unfamiliar. Such changes are generally attributed to the action of a toxin supposed to be elaborated in the maternal or fœtal organism, but as yet no such toxin has been identified, and many are even skeptical as to its existence. For this reason, it would seem more plausible to attribute them, as well as the metabolic changes associated with many of the abnormalities of pregnancy, to functional alterations in certain of the endocrine glands, although it must be admitted that at present such views are hypothetical, and may be altogether unfounded.

With increasing knowledge of some of the more usual modifications of normal metabolism, the necessity for the accurate control of all the factors concerned in such studies has become more fully appreciated, and as such control was palpably lacking in certain of the older investigations concerning the toxemic conditions, it has become necessary to disregard the conclusions based upon them. Up to the present, even the most careful metabolic studies have done little toward revealing their underlying causes, and at best have only served to render untenable certain hypotheses which formerly enjoyed a considerable vogue.

It should always be borne in mind that totally different pathological conditions may be accompanied by identical clinical manifestations, so that a proper classification cannot be based upon the occurrence of such symptoms as albuminuria, fever, coma, or convulsions, but must depend upon our ability to isolate certain specific poisonous principles, or to demonstrate distinctive pathological lesions. Unfortunately, the former is as yet out of the question, but the latter has already been accomplished along certain lines. We shall therefore consider separately the following groups of "toxemia of pregnancy": (*a*) pernicious vomiting; (*b*) acute yellow atrophy of the liver; (*c*) low reserve kidney; (*d*) pregnancy complicated by chronic nephritis; (*e*) preëclamptic toxemia; (*f*) eclampsia; and (*g*) certain unclassified toxemias.

PERNICIOUS VOMITING OF PREGNANCY

We have already referred to the ordinary type of nausea and vomiting, which is noted in the early weeks of gestation. This occurs in approximately one-half of all pregnant women, usually appearing at about the sixth week, and disappearing spontaneously six or eight weeks later. In such circumstances the patient suffers from nausea, or even vomits shortly after arising, whence the term "morning sickness." In other cases the vomiting occurs at other times and at more frequent intervals, occasionally lasts for a longer period, while exceptionally it becomes so frequent and severe as to put the life of the patient in danger. In the latter circumstances, it is designated as pernicious vomiting.

Ordinarily, the so-called "morning sickness" is attended by no more serious results than the actual discomfort connected with it, and many women consider it so natural an accompaniment of pregnancy that they do not complain of it. Others, however, soon demand relief from the physician, and the mere enumeration of some of the many remedies recommended affords conclusive evidence that a specific cure has not yet been discovered. In some instances the first remedy administered is followed by immediate relief, while in other cases various drugs may be employed in succession without result. Relief sometimes follows the administration before each meal of a capsule consisting of 2 grains of pepsin and ¼ grain nitrate of silver. Oxalate of cerium in 5-grain capsules, corpus luteum tablets, dilute tincture of iodine, dilute hydrocyanic acid, cocaine or bismuth are also recommended.

In my hands, however, drugs are rarely required, except for the relief of constipation, and the condition can usually be cured, or at least greatly ameliorated, by suggestion, the adoption of more hygienic methods of living, and regulation of the diet. The physician should not make light of the condition, but he should impress upon the patient that vomiting is not a necessary accompaniment of pregnancy, as is shown by the fact that less than one half of all pregnant women suffer from it, and furthermore that it can be controlled by exercise schumacher.

of the will, and the adoption of suitable and dietetic measures. He should then inquire carefully into her mode of life, and see that proper exercise, occupation, amusement, and rest are obtained. The diet should be carefully regulated. I lay great stress, particularly on account of its suggestive influence, upon the patient eating a hard dry biscuit, such as one uses with cheese, the moment she awakens and before raising her head from the pillow. Afterwards breakfast may be taken in bed, or not, according to her habit. The important point, however, is to arrange that food be taken at frequent intervals throughout the day, so that the patient gets six small meals instead of three larger ones. It is not sufficient to prescribe this in general terms, but precise directions should be given as to exactly what should be eaten at definitely appointed hours. If the patient be impressed with the necessity of following these minutiæ implicitly, the condition will usually pass off within a few days and the employment of drugs will be unnecessary.

Occasionally, the vomiting becomes more frequent and severe, so that in extreme cases no nutriment of any kind, not excepting water, can be retained. The condition is then known as pernicious vomiting, which, unlike the ordinary morning sickness is a serious disease, and sometimes leads to a fatal issue, no matter how treated.

According to Pick, pernicious vomiting occurs about once in every 1000 pregnant women in Europe, but in our material approximately one woman out of every 150 suffers sufficiently from it to seek relief in the clinic. The incidence is approximately the same in white and black ward patients, but is higher among the neurotic women of the upper classes. In general, it appears to occur less frequently in England and Germany.

Etiology.—Since pernicious vomiting is always preceded by the so-called morning sickness, and as the latter occurs in approximately every other pregnant woman, it may be assumed that the cause of vomiting in general must be sought in some factor commonly present in normal pregnancy; and, consequently, that pernicious vomiting is due to an increase in the amount or in the potency of that factor, or to decreased resistance to its action on the part of the woman. Harding, Titus and his associates, Dieckmann and Crossen, and other writers attribute it to depletion of the glycogen stores of the liver. On the other hand, the constant entrance into the maternal circulation of fragments of chorionic villi (deportation), the presence in the maternal blood of whatever substances give rise to the Abderhalden reaction, as well as of increased amounts of "folliculin," which can be demonstrated in the urine, all indicate the existence of conditions, which by slight aberration might give rise to clinical symptoms. Roughly speaking, alterations in any one of these factors, as well as a decrease in the resistance on the part of the mother to their action, afford a theoretical basis for a "toxemic" origin, which I believe is concerned in all cases of vomiting of pregnancy, whether mild or severe. Unfortunately, however, our knowledge along such lines is still so defective that any theory concerning the etiology of the condition must be regarded as tentative.

In my monograph, which appeared in 1906, I stated that the evidence then available seemed to justify the differentiation of three types of serious vomiting, namely, reflex, neurotic and toxemic. I now believe that practically every case rests upon a toxemic basis, and that variations in its course depend upon the severity of the underlying toxemia. In occasional instances, the toxic influence is predominant, when we have to deal with toxemic vomiting *par excellence*. Fortunately, however, in the great majority of cases this factor appears to act merely as a predisposing cause in neurotic women, and becomes negligible after the nervous equation has been controlled. These are the cases of neurotic vomiting, which make up the bulk of those we are called upon to treat. I have abandoned the conception of reflex vomiting, as increased experience has taught me that it should be regarded as a subdivision of the neurotic type. In general, it may be said that true toxemic vomiting is a very serious affection, which frequently leads to death; while neurotic vomiting is readily amenable to treatment and can usually be cured by suggestive means.

Matthews Duncan, in 1879, pointed out that pernicious vomiting is sometimes associated with serious hepatic lesions, but this was not generally recognized until the work of Stone, Ewing, and myself showed that in many of the fatal cases characteristic lesions are present in the liver and kidneys, and are identical with those occurring in acute yellow atrophy. In such cases there is profound necrosis of the central portion of the lobules, while the periphery remains intact, and in several of my specimens the destruction of tissue was so great that practically nine-tenths of the organ was thrown out of function (Fig. 483). Winter, Hofbauer, Heinrichsdorff, Schickele and others have described similar changes. In other fatal cases, the characteristic necrosis is absent, but the liver has undergone such marked fatty degeneration that upon staining frozen sections with Sudan the entire specimen seems to be filled with fat. This type of lesion is usually noted in women dying after a long illness, and is probably a manifestation of starvation, rather than of acute toxemia. The renal lesions are degenerative in character, and are practically limited to the convoluted tubules, whose epithelium in many cases is necrotic and whose lumina are filled with débris. As a rule, the renal changes occur only in the terminal stages of the disease.

As the hepatic necrosis is altogether different from that observed in eclampsia, in which the process begins in the periportal spaces and is primarily due to thrombosis, I hold that toxemic vomiting is an entirely distinct process, and that it has only three points in common with eclampsia, namely, that both occur in pregnant women, are manifestations of disturbed metabolism and are accompanied by hepatic lesions. It should not, however, be believed that the essential process in either disease consists in the liver lesions, but rather in the underlying toxemia to which they are due.

The researches of Opie upon zonal necroses of the liver lend still further support to the toxemic basis of vomiting, as he pointed out that central and midzonal necroses are usually the result of systemic poisoning. Moreover, it is well known that other poisons which act upon the liver—chloroform, arsenic, phosphorus and carbon tetrachloride—likewise produce cell destruction in these areas, while the peripheral portion of the lobules is spared to the last. Additional evidence of the toxemic origin of the vomiting is occasionally afforded, in patients who ultimately recover, by the development of a polyneuritis, which is associated with characteristic disturbances in sensation, motility and nutrition of the affected parts. Such a complication was first described by Whitford, and Job, in 1911, collected 16 such cases from the literature, while I have observed several.

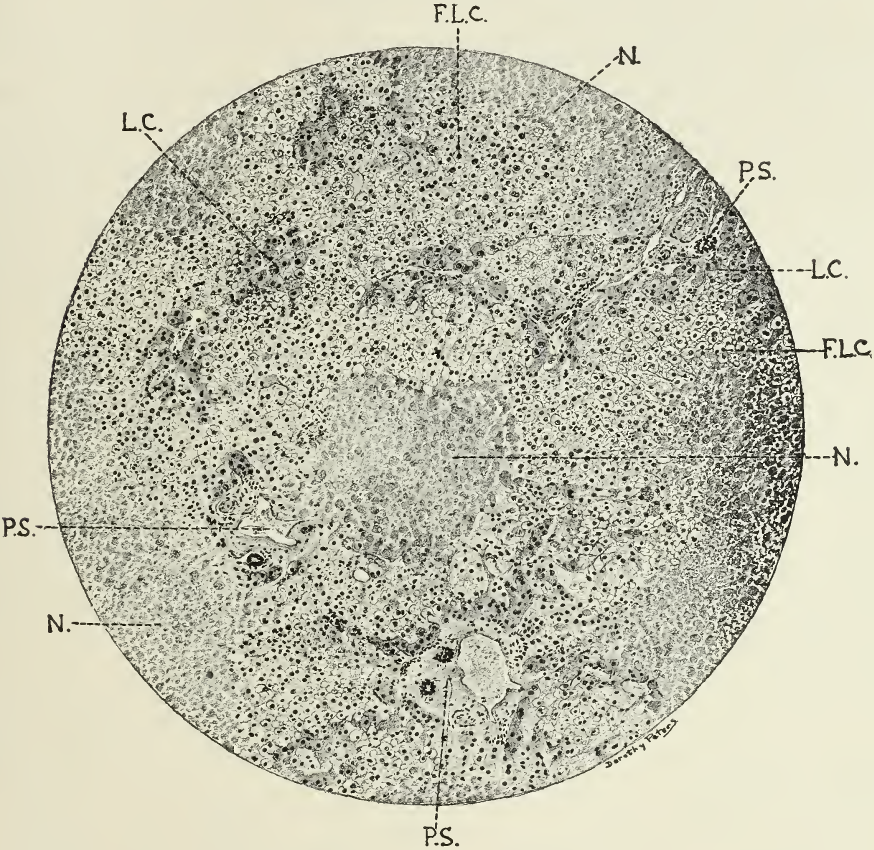

Fig. 483.—Liver from Vomiting of Pregnancy Showing Central Necrosis. × 50. *F. L. C.*, liver cells showing fatty degeneration; *L. C.*, unchanged liver cells; *N.*, areas of necrosis; *P. S.*, portal space.

In my original article, I pointed out that in true toxemic vomiting a high ammonia coefficient could be demonstrated in the urine, so that instead of 3 or 4 per cent of the total nitrogen being excreted in the form of ammonia, the figure might rise to 10, 20 or even 40 per cent. This I attributed to such perversion in the intermediary protein metabolism, as a result of the hepatic changes, that incompletely oxidized substances were excreted in large quantities instead of urea, and for a time I believed that the existence of a high ammonia coefficient would enable us to differentiate between toxemic and neurotic vomiting. This, however, was soon shown to be erroneous, as Longridge, Leathes, and others pointed out that the high ammonia coefficient could be a manifestation of an acidosis, while Rand and Underhill considered it an accompaniment of an acidosis due to inanition. Finally, in 1921, Nash and Benedict demonstrated that the urinary ammonia is produced in the kidneys as an essential part of the mechanism for neutralizing such acids as are brought to them for excretion. For these reasons, it must be admitted that the presence of a high ammonia coefficient does not necessarily give any information as to the existence of serious hepatic lesions, and consequently cannot be relied upon for the differentiation between the several types. In 60 cases from our service analyzed by Peckham in 1929, the ammonia coefficient averaged 15.35 per cent, and in general was low in the mild, and high in the severe cases of vomiting; yet such striking exceptions to the general rule occasionally occur as to deprive it of any diagnostic significance.

Numerous investigators have studied the blood chemistry in serious vomiting in the hope of learning more about the changes in metabolism and possibly of obtaining a clue as to the treatment to be pursued. These are well summarized in the papers of Peckham (1929), and Dieckmann and Crossen. In general, it may be said that there is little change in the mild, but that considerable changes occur in the severe cases. In the latter there is a definite increase in the non-protein nitrogen, uric acid and sugar content, a moderate decrease in the chlorides and little change in the carbon dioxide combining power, as is shown in the accompanying table from Peckham's paper, giving the average findings in 60 cases studied in this clinic:

	Normal Early Pregnancy	Mild Vomiting	Severe Vomiting
Number of cases	7	33	27
Non-protein nitrogen	34.3	33.3	57.5
Uric acid	2.4	3.3	6.1
Sugar content	98.3	97.8	134.1
Chlorides	539.3	497.2	462.5
Carbon dioxide combining power	49.8	49.3	48.3

In general it may be said that the changes in the severe cases may be attributed to the dehydration which inevitably accompanies the process, while the striking rise in uric acid may indicate destruction of tissue. On the other hand, the rise in blood sugar speaks strongly against the views of Harding and Titus that the process is associated with hypoglycemia. Furthermore, the absence of change in the carbon dioxide combining power indicates that in most cases we do not have to deal with a pronounced acidosis. Naturally, it may be objected that such average figures may mask important variations, and that this is the case is shown by the analysis of our findings. Thus, in four patients the CO_2 readings fell below 40, and in four others exceeded 60 volumes per cent. In other words, some of the patients presented a mild acidosis and others a considerable alkalosis, yet in each group three of the patients suffered from severe and one from mild vomiting. Such figures, however, are sufficient to indicate that general rules cannot be laid down, and that variations in the blood chemistry do not afford unassailable indications for treatment, but rather indicate that the changes are the result rather than the cause of the vomiting.

The belief in the existence of neurotic vomiting cannot be based upon anatomical findings, as patients suffering from it rarely die, and then only after a prolonged illness as the result of inanition. Particular attention was directed to it by Kaltenbach who, in 1891, stated that the vomiting of pregnancy is usually a manifestation of a neurosis, somewhat allied to hysteria, and is readily amenable to suggestive treatment. Clinical observation affords abundant evidence in favor of such a view, as it is well known that many women, who are apparently on the verge of death from starvation, suddenly become better spontaneously following a threat to induce abortion. Moreover, prompt cure sometimes follows the mere administration of an anesthetic, or the employment of the most varied and unscientific means of treatment, such as the use of an electrical battery which does not function, or the application of leeches to various parts of the body, or of medicaments to the cervix. Furthermore, it may be safely assumed that the cures following dilatation of the cervix, as recommended by Copeman, are in reality due to suggestion.

Although, as has already been intimated, all types of vomiting in pregnant women are probably primarily dependent upon a "toxic" basis, the chief argument in favor of neurotic vomiting is afforded by the surprising regularity with which cure can be effected when suggestive means are intelligently employed, as will be described later, which would seem to indicate that, once the abnormal neurotic tendency has been overcome, the organism can cope with the underlying factor—whatever it may be. I no longer consider reflex vomiting as a distinct type, although every one has occasionally observed serious vomiting in women with uterine displacements, ovarian tumors or some other lesion of the sexual organs, and has noted immediate relief following their correction or removal. With more extended experience I have come to doubt the etiological connection, and now attribute most of the cures to suggestion.

Since 1916, J. C. Hirst has advocated the view that vomiting of pregnancy is dependent upon deficient corpus luteum secretion, and bases his belief upon the fact that at autopsy the corpus luteum may be in a cystic condition. (This, however, is by no means a constant finding.) He reports satisfactory cures following the intramuscular or intravenous administration of commercial solutions of corpus luteum extract. As he admits that the condition sometimes proves refractory to such treatment, and as we obtain equally good results without its use, I am inclined to attribute to suggestion whatever good it may accomplish.

Symptoms.—Ordinarily, pernicious vomiting begins as the simple vomiting of pregnancy, which gradually becomes so severe that nothing can be retained by the stomach. Unfortunately, the mere severity of this symptom gives no clue as to whether one has to deal with the neurotic or toxemic type. In the former the vomiting may continue for weeks, the patient gradually becomes more and more emaciated, and eventually dies of starvation if suitable treatment be not instituted.

True toxemic vomiting may occur in either acute or chronic form. In the former the disease pursues a rapid course, and the patient, after a few days of ordinary vomiting, may begin to eject coffee-ground vomitus, soon passes into a somnolent or comatose condition, and dies within a week or ten days without emaciation. In the latter, and more frequent, variety, persistent vomiting may continue for weeks, the patient becoming markedly emaciated before the seriousness of the condition is appreciated. Later she begins to vomit coffee-ground-like material, which she rejects in large quantities and without apparent effort. At this time symptoms indicative of toxemia appear, the patient becoming torpid or violently excited and finally passes into a condition of coma. In some instances, slight jaundice may develop, and, toward the terminal stage of the disease, the urine becomes greatly diminished in amount, and contains albumin, casts, and even blood. Even in patients who ultimately recover, great emaciation may occur, so that losses of 20 to 30 pounds are not unusual, while one of our patients lost 46 pounds.

Formerly it was taught that in the later stages of the disease fever frequently occurred, and was associated with a rapid and thready pulse and pronounced albuminuria. This, however, has not been my experience, as the temperature did not exceed 101° F. in any of my fatal cases. The behavior of the pulse is not constant—in some cases it soon becomes rapid and thready, while in others it is scarcely accelerated. Several of my patients have recovered with a pulse above 140, while in a fatal case it did not exceed 96. For these reasons, I cannot accept Pinard's dictum that abortion should always be induced whenever the pulse rate continues higher than 100.

Diagnosis.—The diagnosis of pernicious vomiting should be made whenever the vomiting is constant enough to interfere seriously with the nutrition of the patient. The differentiation between the toxemic and neurotic types is sometimes difficult, but, as the latter occurs much more frequently, the presumption should be in its favor unless isolation and suggestive therapy fail to bring about improvement. Acute toxemic vomiting is readily recognized, but from my experience it is impossible by a single clinical examination to diagnosticate the chronic variety. Thus, it may happen that two women may appear to be equally ill when first seen and to present the same degree of inanition, yet one will be suffering from neurotic and the other from toxemic vomiting, and the former will recover within a few days after suggestive treatment, while the latter may die even after abortion has been induced.

A thorough physical examination should be made, and if any serious abnormality of the generative tract be detected, it should at once be corrected on the assumption that it may reflexly aggravate the symptoms. If no lesion can be detected, the diagnosis lies between neurotic and chronic toxemic vomiting, with the probabilities greatly in favor of the former. The urinary and blood chemistry should be carefully studied. If they are normal, it is probable that we are dealing

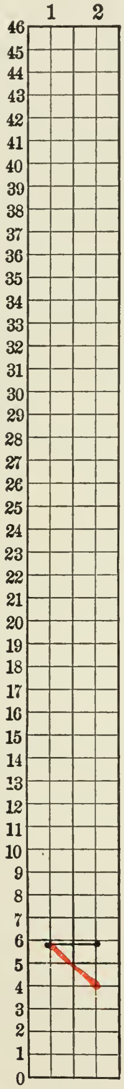

FIG. 484.—URINARY CHART, NEUROTIC VOMITING. In this and the following charts each square corresponds to 1 gram of total nitrogen and 1 per cent of ammonia nitrogen. Total Nitrogen: Black, Ammonia: Red.

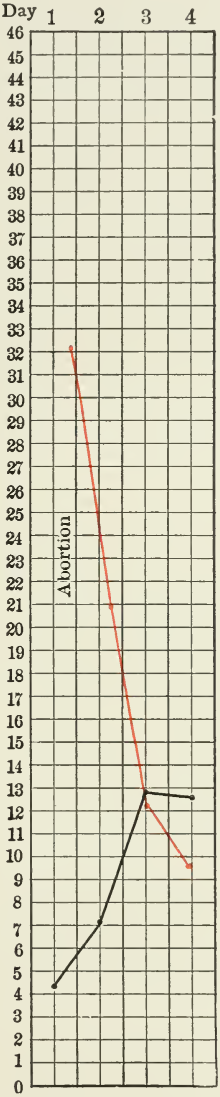

FIG. 485.—URINARY CHART, TOXEMIC VOMITING, RECOVERY AFTER INDUCED ABORTION. Total Nitrogen: Black, Ammonia: Red.

with the neurotic type; whereas if the ammonia coefficient is high, and the blood chemistry shows the changes to which reference has already been made, the diagnosis is more dubious, but with the changes still in favor of the neurotic type. On the other hand, if jaundice develops, and more particularly if the vomitus becomes coffee-ground in character, the diagnosis of toxemic vomiting should be made and abortion induced without delay. If, however, these signs are lacking, it will be necessary to defer the diagnosis until the effect of the treatment to be described can be observed. Generally speaking, if no improvment follows five or six days of hospital treatment, the condition is probably not neurotic, and the propriety of emptying the uterus should be considered.

Prognosis.—The prognosis is extremely satisfactory in neurotic vomiting, as cure can usually be effected within a week by suggestive treatment, provided the physician is sufficiently sure of himself to be able to impress his belief upon the patient. On the other hand, the prognosis is always grave in the toxemic variety, as we have no means of determining to what extent the internal lesions have progressed, or whether it is possible for them to undergo repair, even if the underlying cause of the toxemia be removed by terminating the pregnancy. In any event, it should be remembered that a certain proportion of such cases will die no matter what may be done.

As has already been indicated, with the exception of jaundice, coma and coffee-ground vomitus, the clinical symptoms alone are of little aid in formulating a prognosis. Moreover, experience teaches that neither excessive loss of weight, rapidity of pulse, nor the existence of fever, of albuminuria, or of acetone in the urine or breath is incompatible with recovery and the continuance of pregnancy.

Pernicious vomiting sometimes recurs, and many women suffer repeatedly from the neurotic variety in succeeding pregnancies. Unfortunately this may also occur in the toxemic variety, consequently the mere recurrence of vomiting in a subsequent pregnancy does not necessarily indicate that one has to deal with the same type.

Treatment.—Formerly the treatment of pernicious vomiting was very unsatisfactory. This was in great part due to the fact that in the neurotic variety cure sometimes occurred when the patient was almost *in extremis,* so that the physician usually deferred inducing abortion in the hope that such an outcome might occur in his case. Consequently, interference was usually postponed until the patient was so ill that death was inevitable, no matter what was done. The recognition, however, of the several types of vomiting just described affords valuable information as to the treatment to be pursued, and indicates that abortion is usually unnecessary in the neurotic, but is frequently deferred too long in the toxemic type.

When abnormalities of the generative tract are discovered, they should be corrected: the displaced uterus should be replaced and held in position by a properly fitting pessary, or the ovarian tumor should be removed, as the case may be. In all serious cases, the patient should be strictly isolated in a well-regulated hospital, and be under the charge of an intelligent nurse. Experience teaches that proper isolation is impossible in the ordinary home, as the well-meant sympathy of the husband or mother may undo all that our suggestion has accomplished. In the neurotic type of vomiting, the patient should be assured that her condition is not alarming, will not require active intervention, and will yield to treatment within a few days. Such assurance should be constantly repeated by all who come in contact with her, and she should be made to feel that ultimate cure is certain—promptly, if she is willing to make the necessary effort, and more slowly, but just as inevitably, if she does not coöperate. For the first twenty-four to forty-eight hours nothing should be given by mouth—not even water or ice—but each day 2500 to 3000 cubic centimeters of fluid should be introduced, in the form of 5 per cent glucose solution per rectum or intravenously and of normal saline solution subcutaneously. By this means the dehydration is relieved, and ordinarily by the third day the patient begins to complain of hunger, after which small amounts of fluid nutriment should be given at frequent intervals, and promptly followed by solid food. The rectal and subcutaneous administration of fluids should be diminished in proportion as food and fluids are taken by mouth.

If improvement does not follow these simple measures, the physician will do well to make a more urgent suggestive appeal to the patient, such as lavage after each attack of vomiting, or the use of a dull needle for the subcutaneous injection of the saline solution. For years we have employed with the greatest success this method of treating neurotic vomiting, with the result that in 60 patients treated during the eight years ending January 1928 abortion was induced in only two instances, and the subsequent history of one of these patients indicates that it was probably unnecessary. I have been unable to confirm the claims of Fieux and others that cure frequently follows the injection of 10 or 20 cubic centimeters of serum obtained from a normal pregnant woman, and I believe that when satisfactory results are obtained by such means they should be attributed to the suggestive effect of the procedure.

In the acute toxemic variety, on the other hand, prompt induction of abortion is the treatment *par excellence,* and should be performed as soon as the diagnosis is made. On account of the possibility of chloroform still further damaging the liver, anesthesia should be local, or induced by means of ether or nitrous oxide, and the uterus emptied by the most conservative method: Vaginal hysterotomy if the cervix is rigid, or dilatation by means of Goodell's or Hegar's dilators if it be soft and patulous. Following the operation, 5 per cent glucose solution should be freely administered per rectum, and in urgent cases intravenously, more particularly as Whipple and his associates have shown that degenerative changes in the liver are most rapidly regenerated in the presence of an abundant supply of carbohydrates. For a time, at least, the administration of food should be regarded as a matter of secondary importance.

The belief that an acidosis is an essential part of the process led many in the past to attempt to combat it by the intravenous administration of sodium bicarbonate, which I am convinced sometimes led to death of the patient from alkalosis. When, however, a real acidosis is present, as shown by a pronounced decrease in the carbon dioxide combining power of the plasma, better results will be obtained by the use of insulin in combination with a protective dose of glucose, as first recommended by Thalheimer. This is rarely necessary, and should never be done unless controlled by accurate determinations, as in the 60 patients studied by Peckham only 4 showed a combining power of 40 volumes per cent or less, while in a similar number the figures exceeded 60 per cent. In other words, in our patients alkalosis was as frequent as acidosis, and would have been accentuated by alkaline or insulin therapy.

ACUTE YELLOW ATROPHY OF THE LIVER

Acute yellow atrophy of the liver (icterus gravis, typhoid icterus, etc.) is an acute and widespread autolytic necrosis of the liver cells, characterized clinically by jaundice, reduction in the size of the liver, and toxic disturbances of cerebration, proceeding to a fatal issue. The disease has been observed in both sexes and at all ages, and is a rare but very serious complication of pregnancy. Kerkring, in 1706, was the first to report a fatal case in a pregnant woman, but since then every one who has studied the disease has laid stress upon the association. Thus, Thierfelder found that 62 per cent of the 143 cases which he collected from the literature had occurred in pregnant women, while Quincke placed the incidence at 60 per cent. It is ordinarily observed during the second half of pregnancy or early in the puerperium, although Beatty and Masson have described cases at the sixth and eighth weeks of gestation, respectively.

Etiology.—Nothing definite can be said concerning its causation, although several conditions are known to predispose toward the production of the disease. Thus, certain poisons (chloroform, arsenic, mercury, phosphorus and carbon tetrachloride), and several diseases, such as syphilis, septicemia and chronic passive congestion and cirrhosis of the liver, are at times associated with lesions, which cannot be distinguished from those occurring in the idiopathic form. In the production of this latter, and larger group, it is generally assumed that a specific toxin circulating in the blood must be concerned. The majority of the cases occurring in pregnant women belong in this category, although not a few of the recorded cases were probably due to delayed chloroform poisoning.

Pathology.—In acute yellow atrophy the liver rapidly diminishes in weight, which in a comparatively short time may be reduced to less than one-half of the normal. Its capsule assumes a wrinkled appearance and the entire organ becomes softened. On section it varies from dark red to almost chrome yellow in color, and upon closer examination each lobule is seen to present a reddish center surrounded by a yellowish periphery.

The histological findings vary according to the severity of the disease. In mild cases the center of each lobule has undergone necrosis and the cells of the periphery present an almost normal appearance, while between the two is a thicker or thinner zone of cells presenting more or less advanced fatty degeneration. In other cases almost the entire parenchyma of each lobule is destroyed and is converted into a mass of necrotic débris, while about the periphery only an occasional well-preserved liver cell is seen; at the same time the interlobular spaces with their blood vessels and biliary canals are but little changed. The kidneys present signs of acute nephritis and the epithelial cells lining the convoluted tubules are in all stages of degeneration, and in extreme cases are entirely necrotic, while the lumina are filled with casts and débris. On the other hand, the glomeruli and the cells lining the collecting tubules are but little changed.

Symptoms.—The symptoms are identical whether the disease occurs during pregnancy or the puerperium, and if convulsions appear it is usually mistaken for eclampsia. In acute cases the symptoms may come on so suddenly as to arouse a suspicion of phosphorus or some other form of poisoning. Thus it may happen that a woman, who previously was in apparently perfect health, may be seized with pains in the abdomen, intense headache, and possibly severe vomiting and purging. In a short time she becomes torpid or violently delirious and soon passes into a condition of coma, which may be disturbed by convulsions. In most cases the coma continues for a few hours or days until death supervenes, but recovery may occasionally occur. There is generally a certain amount of jaundice, which may vary from a mere discoloration of the conjunctivæ to pronounced general icterus. The vomited matter is frequently blood-stained, and sometimes assumes a coffee-ground appearance. The urine is diminished in amount, very highly-colored, and contains albumin, all varieties of casts, and frequently large quantities of blood. Fever is usually absent, or the temperature may be even subnormal until just before death when it may rise to a high point. The pulse and respiration tend to be rapid, and the blood pressure remains normal until renal insufficiency develops. Due to the concentration of the blood the red blood cells are slightly increased in number, and the leukocytes somewhat more so, while the hemoglobin content is diminished. In delayed chloroform poisoning the symptoms are very similar, and death usually occurs within the week following the anesthesia. Should the patient survive for a longer period, the chances for recovery are excellent.

In other cases the course of the disease is less rapid, and in its early stages may simulate an ordinary preëclamptic toxemia. Slight jaundice, however, soon appears, and the patient gradually becomes more and more apathetic and torpid, and eventually passes into a condition of coma, which usually terminates in death. In this class of cases the diminution in the size of the liver may be traced by percussion, and in one of my patients the area of hepatic dullness became diminished by more than one-half in the course of a week. If the disease occurs during pregnancy, the fœtus usually dies as a result of the toxemia, and may be expelled from the uterus. In such cases, examinations of the fœtal organs may reveal extensive hepatic and renal lesions, and thus aid in establishing the diagnosis before the death of the mother. When recovery ensues, the convalescence is tedious, not so much on account of the damage to the liver, which is relatively quickly repaired, but as a result of the renal insufficiency.

Chemical examination of the urine shows changes analogous with those already described in toxemic vomiting, and similar to those observed in acute phosphorus poisoning. The total nitrogen is usually increased, and its partition always presents marked changes, the urea being always diminished and the ammonia coefficient greatly elevated. Moreover, there is a marked increase in the amino-acids, and crystals of leucine and tyrosine may be demonstrated by appropriate procedures. Small quantities of acetone bodies are usually present.

The blood chemistry has been studied in too few cases to permit any general conclusions. In a case studied by Stadie and Van Slyke, the urea nitrogen was within normal limits, but the amino-acid nitrogen was so increased as to exceed it, while the total nonprotein nitrogen was not determined. The plasma bicarbonate was at first above normal, but gradually fell, reaching 49 volumes per cent on the day of death. It would accordingly appear that a primary alkalosis had been replaced by an acidosis as the end approached. Examination of the liver showed that it contained three times the normal amount of amino-acids. Such variations in the amino-acid metabolism are satisfactorily explained by supposing that, as the result of cell destruction, the liver function had become so insufficient as to affect the normal mechanism for deaminizing the amino-acids and for synthesizing urea. It is generally agreed that the increased amino-acid content of the blood results from autolysis of the liver cells, rather than from the absorption of the products of intestinal digestion.

Diagnosis.—The diagnosis can usually be made from the clinical findings and history. Although the occurrence of convulsions may lead to a suspicion of eclampsia, the appearance of jaundice should always be suggestive, in which case chemical examination of the blood and urine should confirm the diagnosis. When occurring in early pregnancy the condition cannot be differentiated from toxemic vomiting, since the lesions, symptoms and urinary changes are identical. In rare cases of gas bacillus puerperal infection, the patient may present all of the clinical signs and chemical findings of acute yellow atrophy. In 1928, I made such a diagnosis, but autopsy showed that the liver did not present the characteristic lesions, but instead contained gas cysts, and that death was due to gas bacillus infection. Kohl has described a similar experience. The prognosis is always bad, the possibility of recovery depending upon the extent of the organic lesions; and as this cannot be determined during life, one should be most cautious in expressing a hope of recovery.

Treatment.—If the condition occurs during pregnancy, the uterus should be emptied as rapidly as is consistent with the safety of the patient, and the various excretory organs stimulated, as will be described under Eclampsia. During the puerperium the latter is the only treatment available. Since the work of Whipple and his collaborators, the intravenous administration of glucose solutions has been recognized as most useful in protecting the liver from further damage and in stimulating its repair. For this purpose, 500 cubic centimeters of a 10 or 20 per cent solution may be administered every four hours, and if precautions are taken to avoid the production of an alkalosis, sodium bicarbonate may be added to the solution.

LOW RESERVE KIDNEY

The more we learn concerning the so-called "toxemia of pregnancy," the more we become convinced that in the past several radically different processes had been grouped together under that term, and that clear thinking, as well as the welfare of our patients, will be best served if we attempt to differentiate them. In this country, it is customary to designate as preëclamptic toxemia all conditions arising in the pregnant woman which are associated with edema, albuminuria and elevated blood pressure, and which are not accompanied by actual convulsions; while in Germany they are grouped together as the toxicosis of pregnancy, or are designated by such bizarre terms as "Gestose" or "Œdneklose." For years I have differentiated between nephritic and preëclamptic toxemia, but since 1926 I have subdivided the latter into low reserve kidney, preëclampsia and an unclassified group, which includes conditions which cannot be placed in either of the other categories. In this, I have followed the suggestion of Stander and Peckham, which was based upon the study in our clinic of repeated pregnancies occurring in patients who had previously suffered from "toxemia of pregnancy."

I am aware that any classification must be unsatisfactory until the etiology of the several conditions has been established, but I believe that the tentative use of the one here suggested has proved to be of value. In a series of 801 cases of "toxemia of pregnancy" occurring in our clinic in the six years ending May 1, 1929, in all of which routine chemical studies were made, the following incidence of the several types was noted:

	Per Cent
Vomiting of pregnancy	9.5
Low reserve kidney	34.6
Pregnancy complicated by chronic nephritis	26.7
Preëclampsia	9.2
Eclampsia	12.5
Unclassified	7.5

Of these, the low reserve kidney is the most common, and, omitting vomiting and actual eclampsia, makes up 44 per cent of our cases. It usually appears during the last third of pregnancy, and may or may not be accompanied by subjective symptoms. In many cases the patient notices edema of the ankles and legs, complains of some headache and general malaise, but does not feel seriously ill. Occasionally all subjective symptoms are lacking, so that the condition would escape observation were the blood pressure not taken and the urine examined as part of the routine prenatal care. The blood pressure is always elevated and albuminuria is usually present, along with a few casts. The characteristic feature of this condition is that the blood pressure does not attain great height, as the systolic rarely exceeds 160 and the diastolic 90 milimeters, and that the albumin content does not exceed 2 grams per liter, and frequently is only a fraction of 1 gram. Sometimes excessive gain in weight occurs, and its cause is evident when the edema is pronounced and the urinary output decreased. On the other hand, when the edema is not apparent, we have to deal with an "occult" form, so that occasionally an unusual increase in weight constitutes the first sign of the existence of the condition.

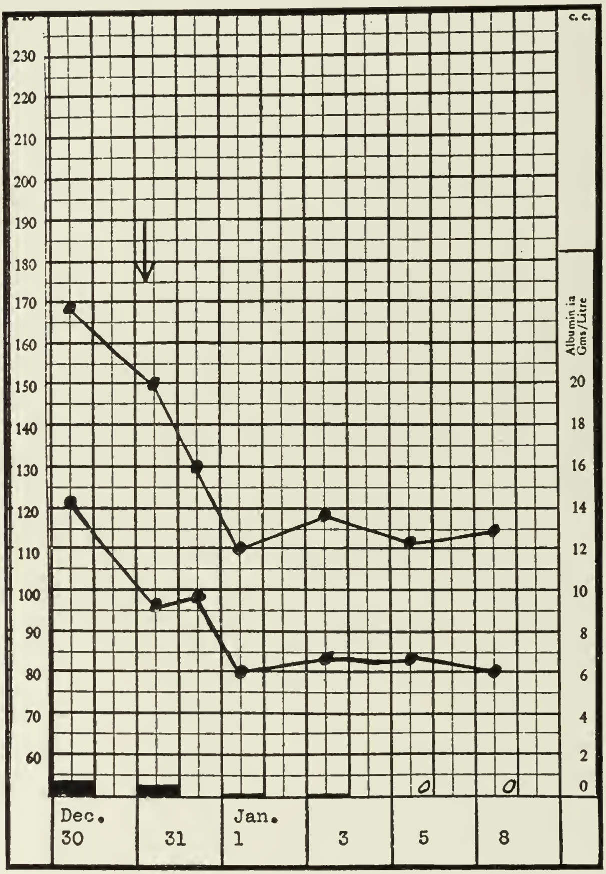

FIG. 486.—BEHAVIOR OF SYSTOLIC AND DIASTOLIC PRESSURE AND ALBUMINURIA IN LOW RESERVE KIDNEY.
Arrow indicates day of delivery.

The low reserve kidney is usually alleviated by rest in bed and a restricted diet, and disappears spontaneously within two or three weeks following delivery. It may or may not recur in subsequent pregnancies, and, when it does, it presents the same mild clinical picture. In other words, it does not tend to become aggravated, and if properly treated is not followed by eclampsia or chronic nephritis. Chemical study of the blood, the phenolsulphonphthalein test for renal function, and the ability to concentrate the urine remains unchanged.

It is probable that many cases of the so-called kidney of pregnancy, of hydrops gravidarum, as well as a certain proportion of the cases described as nephropathia gravidarum by Zangemeister belong in this category. We are ignorant concerning the etiology of the low reserve kidney. In the normal individual it is estimated that only about one-half of the renal glomeruli function at any one time, so that a large reserve is available. In the condition in question, however, it is believed that this reserve has for some reason become reduced, with the result that, while the kidneys function normally in ordinary life, they become relatively inefficient under the strain of pregnancy. That they are not permanently damaged is shown by the prompt return to normal after delivery, as well as by the fact that symptoms do not necessarily recur in succeeding pregnancies. The edema is explained by supposing that the capillaries have become more permeable, as the result of the action of some "toxin" peculiar to pregnancy, as well as of changes in the colloid constituents of the blood plasma and of the tissues in general.

The treatment is simple, as a few days' rest in bed along with a low protein diet is usually followed by the disappearance of the edema, a considerable loss in weight, the return of the blood pressure to normal and by the disappearance of albumin from the urine. Figure 486 illustrates a spontaneous cure following delivery. The induction of premature labor is rarely necessary, for, if cure is not effected by the treatment just outlined, it is usually possible to carry the patient along until the child has attained such proportions as will insure its welfare after delivery. In occasional instances, however, the blood pressure does not fall materially, while the albumin persists between 1.5 to 2 grams per liter, and in them it is well to induce labor as soon as the child is viable, less with the idea of preventing the development of eclampsia than of avoiding permanent damage to the kidneys.

CHRONIC NEPHRITIS COMPLICATING PREGNANCY

According to our figures, this constitutes the second most frequent type of toxemia, and, omitting vomiting and eclampsia, makes up 34 per cent of our cases. In most instances the chronic nephritis antedated the present pregnancy, and followed scarlet fever, some other infectious process, or a preceding eclampsia. In other instances the first manifestations appear to develop during the course of pregnancy, when its recognition is frequently impossible until some weeks after delivery.

In my experience chronic nephritis is the underlying factor in certain women who repeatedly give birth to premature infants, and who present a history of being perfectly well up to a certain period of pregnancy when edema, high blood pressure, and albuminuria develop. In such cases, the symptoms may persist for months after delivery, but eventually disappear, to reappear in each succeeding pregnancy.

Except for what has been said, we are completely ignorant concerning the etiology of the nephritic process, but it is assumed that there is something connected with pregnancy which leads to its exacerbation and thus leaves the patient in increasingly worse condition after each succeeding pregnancy. In the cases which come to autopsy, the usual lesions of chronic nephritis are present, to which are added acute degenerative changes in the convoluted tubules. No acute degenerative changes are noted in the liver. The placenta may be normal, or may be occupied by large red or white infarcts, which in some instances are so extensive as to throw out of function so great a part of the organ as to interfere seriously with the nutrition of the child, and thus lead to its death and premature expulsion. Even when the placenta presents no visible lesion, the child tends to be considerably smaller than it should be, and consequently it is inferred that the disturbed metabolism attending the nephritic process has interfered with its development. Indeed, it may be said that with the exception of syphilis, chronic nephritis is the most usual cause of the repeated birth of premature and stillborn children.

When the renal condition antedates the pregnancy and is well developed, exacerbation occurs within a few months after the last menstrual period; whereas, in less pronounced cases symptoms do not appear until after the middle of pregnancy. In either event, the condition is usually accompanied by lassitude, general malaise, headache and marked edema, which may involve all parts of the body. Later, disturbances of vision may occur which are the result of albuminuric retinitis. In other cases, there are no subjective symptoms and the condition would escape recognition were the blood pressure not measured and the urine examined. The behavior of the blood pressure is variable. In many instances the systolic reading is well above 200 millimeters, with the diastolic presenting a corresponding increase. In other cases, a much lower level is noted, and it is particularly in such patients that diagnostic difficulties arise. In either event, the pressure does not fall to normal promptly after delivery, as in low reserve kidney, but remains elevated for months, or permanently. Albuminuria is usually present, and varies in amount from a mere trace to many grams per liter, tending to attain its high point at the time of delivery, to decrease afterwards, but it rarely disappears completely (Fig. 487). The urinary output varies from case to case. It may be considerably diminished, but frequently large amounts of pale urine of low specific gravity may be passed.

The general condition of the patient gradually becomes more serious as term is approached. In rare instances, typical uremic coma may develop, occasionally a true eclampsia may become engrafted upon the nephritic process, but in the great majority of cases delivery occurs without undue complication, and afterwards the disease pursues its usual chronic course, death sometimes occurring within a few months, but is often deferred for years. It is important for the student to remember that there is a tendency on the part of many to exaggerate the rapidity with which the fatal termination follows.

When it is known that the nephritic process has preceded the pregnancy, the diagnosis is simple, but when no definite information is available as to the past history, or when a mild process develops during the course of pregnancy, it becomes very difficult and sometimes cannot be established until weeks after delivery. Functional kidney tests are sometimes of help, as the excretion of phenolsulphonphthalein tends to be diminished, as well as the capacity to concentrate the urine. Study of the blood chemistry sometimes gives valuable aid, particularly when the nonprotein nitrogen reading is high, of which one-half or more is made up of urea nitrogen. Unfortunately, this is not always the case, as it frequently happens that the readings are normal in definitely nephritic cases. Linzenmeier states that the sedimentation time of the blood is increased in

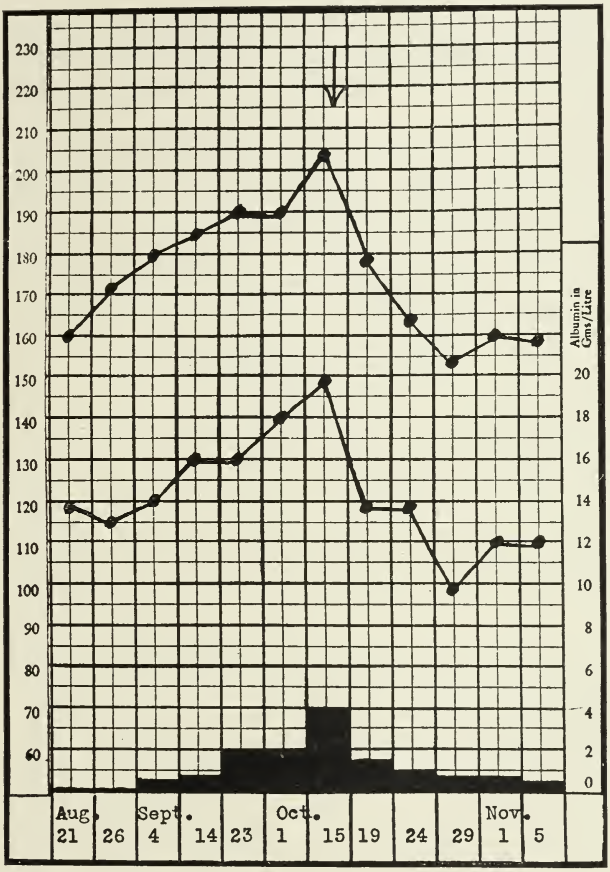

FIG. 487.—BEHAVIOR OF SYSTOLIC AND DIASTOLIC PRESSURE AND ALBUMINURIA IN PATIENT WITH CHRONIC NEPHRITIS COMPLICATING PREGNANCY.
Followed for 55 days before, and 21 days after delivery. Arrow indicates day of delivery.

chronic nephritis as compared with other forms of toxemia, but my experience is too small to permit a statement.

Probably the best method of differentiation consists in the ophthalmoscopic study of the eyegrounds. J. R. Miller, in 1915, reported that retinal hemorrhage and albuminuric retinitis were frequently present in chronic nephritis, but were uniformly absent in the low reserve kidney and preëclampsia. Moreover, when amaurosis develops in the latter condition it is due to retinal edema or to deep-seated toxic degenerative process. Further experience has confirmed these statements, but it should be remembered that, as albuminuric retinitis occurs in only a fraction of the cases, its absence does not militate against the existence of chronic nephritis.

If the patient is not seen until uremia has developed, the condition is usually mistaken for eclampsia; while if a milder process develops during the course of pregnancy, it is sometimes confounded with low reserve kidney or preëclampsia, unless the rise in nonprotein nitrogen is sufficiently high to be characteristic. In most such cases the diagnosis is not assured until long after delivery, but it can be stated as a general rule that if the blood pressure has not returned to normal and the albuminuria has not disappeared within six weeks after delivery a diagnosis of chronic nephritis is permissible. On the other hand, normal conditions at this time do not permit its exclusion, as it sometimes happens that examination of such patients several months later may reveal the characteristic signs of chronic nephritis. In still rarer instances everything seems in order until a new pregnancy supervenes, but a few months after its onset the old train of symptoms reappears. In such circumstances it may be assumed that the renal damage is of so low a grade that it becomes manifest only during pregnancy.

Provided convulsions and coma do not appear, the prognosis is generally good so far as the immediate life of the mother is concerned, but it should always be remembered that each succeeding pregnancy tends to accentuate the process and thus materially shortens the ultimate prospects of life. The prognosis for the child is only fair, as the changes in the placenta, as well as the direct effect of the toxemia, affect its nutrition and development and often lead to its death and premature expulsion. On the other hand, it is well recognized if the poorly developed child is born alive, that its chances of life are far better than for other premature infants of the same weight.

The treatment will depend upon circumstances. Generally speaking the mild cases should be treated along the same lines as the low reserve kidney, while in the severe ones pregnancy should be terminated as soon as serious symptoms appear, without attaching too much importance to the life of the child. In such cases, the danger of subsequent pregnancy should be explained to the patient, and suitable contraceptive advice given. If, however, she is too unintelligent to follow such advice, she should be instructed to report as soon as she again becomes pregnant, when the uterus should be emptied and sterilization effected. It is particularly in this type of patient that I advocate supravaginal amputation of the early pregnant uterus with retention of its appendages.

If, however, pregnancy is well advanced when the patient is first seen, and she is willing to assume an additional immediate, as well as an increased ultimate, risk for the sake of the child, she should be put to bed and carefully watched. If alarming symptoms do not supervene, spontaneous delivery should be awaited and sterilization effected late in the puerperium. Occasionally it may seem wise to resort to cesarean section a few days before the expected onset of labor, and at the same time to effect sterilization by supravaginal amputation of the uterus or by excision of the tubes, according as it is desired to destroy or preserve the menstrual function.

In view of its ultimate danger to the mother and the comparatively poor chances for the child, I have become more and more radical in the treatment of pregnancy complicated by chronic nephritis, and resort to conservative treatment only in relatively mild cases, or when the parents urgently request it, after its immediate and remote dangers have been fully explained.

PREËCLAMPSIA

By the term preëclampsia is understood the toxemia of pregnancy which is the immediate forerunner of eclampsia,, and which will almost inevitably terminate in it if not adequately treated. It corresponds to the so-called "eclampsisme" of continental writers, and is the least common of the several toxemias of pregnancy, constituting 12 per cent of the 625 cases recently studied in our clinic, excluding vomiting and actual eclampsia. Preëclampsia is not identical with preëclamptic toxemia, and fortunately constitutes but a small fraction of the cases usually so designated.

It occurs more frequently in women pregnant for the first time than in those who have borne several children, and usually develops during the last third of pregnancy. In general, it pursues a more acute course than the conditions which we have just considered, and should be suspected whenever the patient complains of intense headache, lassitude, edema, and a decrease in urinary output. The blood pressure is always higher than in the low reserve kidney, and frequently the systolic reading approaches or exceeds 200 millimeters, while the diastolic reading is proportionately high. The albumin content of the urine is usually much greater than in the low reserve kidney and varies from several to 10 or more grams per liter. In many instances the patient appears seriously ill and may be torpid or somnolent. Visual disturbances are common, and ophthalmoscopic examination will reveal the absence of albuminuric retinitis, but may show hemorrhage into the retina or its partial detachment. In many cases, however, the findings are negative, and in such circumstances the amaurosis must be attributed to toxic influences or to deep-seated lesions.

Severe headache, and particularly precordial pain, or a sensation of constriction about the epigastrium are ominous, and indicate that an eclamptic outbreak is imminent. Moreover, Klaften has directed attention to the serious prognostic import of a pronounced increase in the depth of the respirations, which he regards as an indication of an aggravation of the condition. When the toxemia is pronounced, even though it does not lead to eclampsia, the fœtus may suffer, and the spontaneous expulsion of a stillborn premature child is not uncommon. The edema is frequently very marked and usually involves the face and neck, as well as the lower extremities. Its development is associated with a rapid increase in body weight, and Zangemeister has directed our attention to the fact that an abnormally large weekly gain sometimes constitutes the first sign in the development of a toxemia.

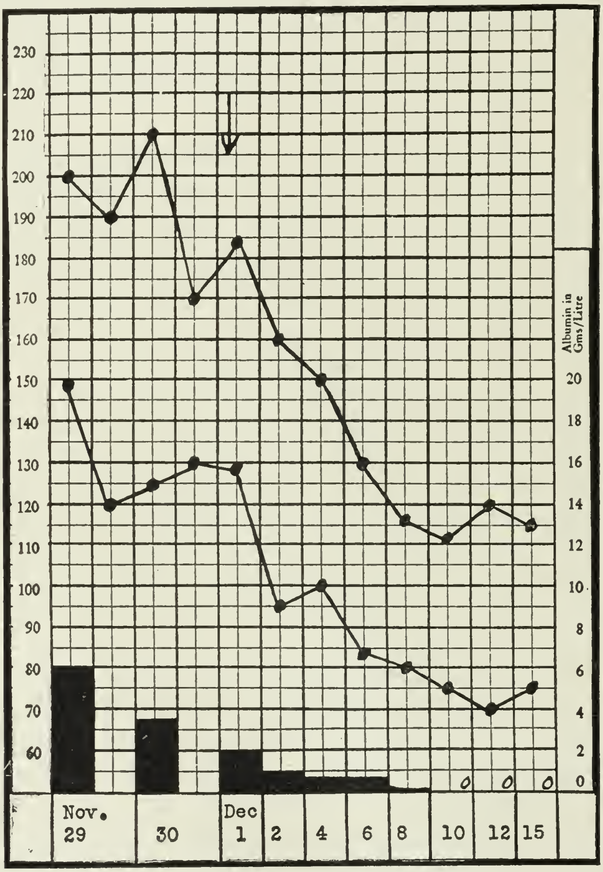

Fig. 488.—Behavior of Systolic and Diastolic Pressure and Albuminuria in Preëclampsia.
Arrow indicates day of delivery.

The excretion of urine may be greatly diminished, and in severe cases it may be entirely suppressed. In addition to albumin, the urine contains casts of all kinds and occasionally blood. Its chemical examination is of little volume, while chemical examination of the blood shows changes analogous to those occurring in eclampsia, but usually slighter in degree. Thus, the uric acid is definitely increased, while the carbon dioxide combining power is sometimes diminished. Ordinarily there is no nitrogenous retention, and the other constituents are within normal limits.

Following delivery, prompt recovery occurs, and usually all signs of the condition disappear by the end of two weeks (Fig. 488). As it is believed that preëclampsia is essentially the initial stage of eclampsia, its etiology will not be considered until that condition is taken up. It might, however, be added that I have not as yet observed any causal relation between it and focal infections in various parts of the body, upon which Talbot and others lay such stress.

Preëclampsia must be differentiated from the low reserve kidney and from chronic nephritis. Ordinarily, the former is easy, as the higher blood pressure, the more pronounced albuminuria, as well as the changes in the blood chemistry, usually permit a prompt decision. On the other hand, when the previous history is not known, it is sometimes impossible to differentiate between it and severe chronic nephritis, and it is here that examination of the eyegrounds serves a useful purpose, as albuminuric retinitis never occurs in preëclampsia. Consequently, when the opthalmoscopic findings are negative, and the patient does not come to autopsy, weeks must elapse before a positive diagnosis can be made. On the other hand, if, at the end of the puerperium, the blood pressure remains elevated and the albuminuria persists, the condition should be considered as nephritic.

It should always be borne in mind that preëclampsia is the toxemia of pregnancy *par excellence,* and that one of the essential aims of routine prenatal care is to detect it in its incipiency and to institute prophylactic measures to prevent the outbreak of eclampsia. Accordingly, the treatment to be pursued will depend upon the seriousness of the condition. As soon as it is recognized, the patient should be sent to the hospital and put to bed. Each day the systolic and diastolic blood pressure should be recorded, as well as the intake of fluids and output of urine, the amount of albumin measured in grams per liter by the Esbach tube, and, if laboratory facilities are available, blood should be withdrawn at frequent intervals for chemical study.

The patient should be placed upon a low protein or an exclusively milk diet, and in addition should be encouraged to drink large quantities of fluid, but I have not been able to convince myself of the necessity for restricting the intake of salt, as is so strongly urged by Harding and Van Wyck, and others. Rochelle or Epsom salts should be administered as necessary, and the weight determined at least twice a week. If improvement follows, the treatment should be continued. But if, on the other hand, the blood pressure continues to rise, the albuminuria to increase, and the changes in the blood chemistry to become more pronounced, labor should be induced by means of a bougie. If, however, the symptoms become more urgent, as indicated by the sudden development of intense headache, epigastric pain, amaurosis or torpor, the only hope of preventing an eclamptic outbreak lies in the prompt termination of pregnancy. If the patient is already in labor, Stroganoff treatment should be commenced, as described in the section on eclampsia, and delivery completed by forceps as soon as the cervix becomes fully dilated. On the other hand, in primiparous patients in whom the cervix is still intact, induction of labor by means of bougie or bag will waste too much valuable time, and in such circumstances cesarean section should be done under local or spinal anesthesia, the usual general anesthetics being avoided on account of their tendency to damage the liver. Fortunately, such radical interference is rarely necessary provided the patients are carefully watched, but I am confident that once every year or so it saves a patient from an eclamptic attack.

Unfortunately, the prophylaxis of eclampsia is not so simple as might appear from what has been said, and will not become so until after its etiology has been discovered. Occasionally it will occur in patients who have had ideal prenatal care, and sometimes in those who are actually under observation in the clinic. In such circumstances the manifestations of preëclampsia do not conform to the classical picture, or the outbreak occurs in patients whose blood pressure is so low that its diagnosis does not seem justified. In other instances albuminuria is lacking, and upon one or two occasions I have seen eclampsia develop in women who the day previously had presented normal blood pressure and albumin-free urine. It is important that such exceptions should be borne in mind, as certain enthusiasts claim that eclampsia can always be prevented and that its occurrence indicates neglect on the part of the obstetrician. Doubtless, this is true in nine cases out of ten, but the undoubted occurrence of the exceptional tenth case proves that all "one hundred percenters" are either misinformed or are careless in the use of words.

ECLAMPSIA

Eclampsia is an acute toxemia occurring in the pregnant, parturient, or puerperal woman, and is usually accompanied by clonic and tonic convulsions, during which there is loss of consciousness followed by more or less prolonged coma, and frequently results in death. Generally, convulsions and eclampsia are considered as synonymous terms, but such a view is not correct, inasmuch as a number of well-authenticated cases of eclampsia without convulsions are recorded, and, moreover, other toxemic conditions occasionally occur in obstetrical practice which are likewise accompanied by convulsions or coma. Accordingly, the only absolutely characteristic feature of the disease is the presence at autopsy of the hepatic lesions which will be described later.

Frequency.—Statistical studies indicate that eclampsia occurs about once in every 500 labors, but it is impossible to determine its incidence with any degree of exactness, inasmuch as few practitioners see a sufficiently comprehensive series of cases in private practice to permit of trustworthy conclusions, while, on the other hand, hospital records by themselves give an exaggerated idea of its frequency, for the reason that many of the patients would have remained at home had they not had convulsions.

The following table would indicate that eclampsia occurs in about 1 per cent of the women entering lying-in hospitals.

	LABORS	CASES OF ECLAMPSIA	
		Number	Per Cent
Goldberg (Dresden, 1891)	10,717	81	0.75
Cassamayor (Paris, 1892)	16,225	99	0.61
Veit (Germany, 1906)	149,366	905	0.61
Reinburg (Paris, 1905)	26,511	90	0.34
Lichtenstein (Leipzig, 1911)	14,836	400	2.68
Williams (Baltimore, 1912)	11,000	110	1.00
McPherson (New York, 1922)	120,000	890	0.75
Hinselmann (Bonn, 1914)	22,716	166	0.73
Cruickshank (Glasgow, 1922)	23,630	814	3.44

In other words, 3555 cases occurred in 395,001 labors, an incidence of 0.98 per cent. Hinselmann places the hospital incidence at 0.39, but I believe that his figure is too low for the reason that his calculation is based in part upon statistics collected at a time when relatively few patients were delivered in lying-in hospitals. On the other hand, the incidence in private practice is lower and varies between one in 500 to 1000 labors. In any event, eclampsia is one of the most important causes of maternal death and Woodbury stated, in 1926, that it and other forms of toxemia were responsible for 26.8 per cent of all deaths occurring in this country from childbirth.

Eclampsia occurs much more frequently in primiparæ than in multiparæ, and Hinselmann estimates that its incidence is 1.5 per cent in the former, as contrasted with 0.25 per cent in the latter. Its frequency varies greatly at different times, Cassamayor stating that in Tarnier's clinic in Paris it was observed many times more frequently in some years than in others. In my experience it often happens that months elapse without the occurrence of a single case, when suddenly a number are observed in quick succession. Such observations have led various writers to discuss the probability of the disease being of infectious origin, but convincing evidence in favor of such a view has not been adduced. Harrar has shown graphically the monthly variations at the New York Lying-in Hospital during a period of ten years (Fig. 482), and considers that the increased incidence in early spring is due to the cold damp weather prevailing at that time. Furthermore, it is generally accepted as true that eclampsia occurs less commonly in warm climates, as well as among those whose diet is largely vegetable in character. During the World War, a decided decrease in its incidence was noted in Central Europe, and many writers have attempted to explain the fact by invoking the change in dietary customs made necessary by the food blockade. Its incidence is also influenced by the extent to which prenatal care is practical, as well as by intelligent prophylaxis. Bar states that this is particularly evident in France, where the incidence had been reduced by two-thirds between 1897 and 1927.

Clinical History.—Eclampsia occurs almost exclusively in the last third of pregnancy and becomes more frequent the nearer term is approached, while in about one-fifth of the cases the first convulsion does not appear until after the completion of labor. Zweifel has reported a case occurring as early as the third month, while a number of writers have reported cases occurring late in the puerperium. Generally speaking, however, reports of eclampsia appearing more than twenty-four hours after delivery should be regarded with skepticism, as careful investigation will usually indicate that the convulsions are of some other origin.

Primiparity, multiple pregnancy and hydramnios are important predisposing factors and it is generally admitted that two-thirds of all cases and upwards occur in primiparous women. Moreover, the disease is noted proportionately six times more frequently in twin than in single pregnancies, and four or five times more frequently when the pregnancy is complicated by hydramnios.

Eclampsia may occur during the course of advanced extra-uterine pregnancy, and Maygrier observed a case in the false labor accompanying that condition. Falk, Sitzenfrey and others have reported cases occurring in association with hydatidiform mole, and I have observed profound preëclamptic toxemia complicating the same abnormality.

An eclamptic convulsion sometimes occurs without warning, "like a bolt from a clear sky," in women who were apparently in perfect health. In the vast majority of cases, however, the outbreak is preceded for a longer or shorter period by premonitory symptoms indicative of preëclamptic toxemia, which was lacking in only 15 per cent of the 2005 cases analyzed by Eden in 1922. The attack may come on at any time, sometimes while the patient is sleeping. If she is awake, the first sign of the impending convulsion is a fixed expression of the eyes, which soon begin to roll from side to side. The pupils are usually dilated, less often contracted. The convulsive movements appear first about the mouth, which begins to twitch and is drawn to one side, the entire face becoming distorted. They extend rapidly in the arm, the body, and finally, to the legs. They are usually clonic in character, though sometimes they take on a tonic form and the patient becomes rigid. The breathing is stertorous, the face congested and flushed, the patient foams at the mouth, and often bites her tongue. During the convulsion, which may last for a few seconds to two minutes, the woman is profoundly unconscious, and after the movements cease passes into a condition of coma which lasts for a longer or shorter period.

More particularly when the disorder appears in the latter part of labor or during the puerperium, a single convulsion only may be observed. Oftener, however, the first is the forerunner of other convulsions, which may vary in number from 1 or 2 in mild, to 10 or 20 or even 100 or more in severe cases, the intervals between them becoming shorter in inverse proportion to the number.

In rare instances they follow one another so rapidly that the patient appears to be in a prolonged, almost continuous convulsion.

The duration of the coma is very variable. When the convulsions are infrequent, the patient usually recovers consciousness after each attack, while in severe cases the coma persists from one convulsion to another, and death may result without any awakening from it. In rare instances a single convulsion may be followed by profound coma, from which the patient never emerges, though, as a rule, death does not occur until after a frequent repetiton of the convulsive attacks. The immediate cause of death is usually edema of the lungs or apoplexy, though if the fatal issue is postponed for several days, it is usually attributable to aspiration pneumonia or puerperal infection.

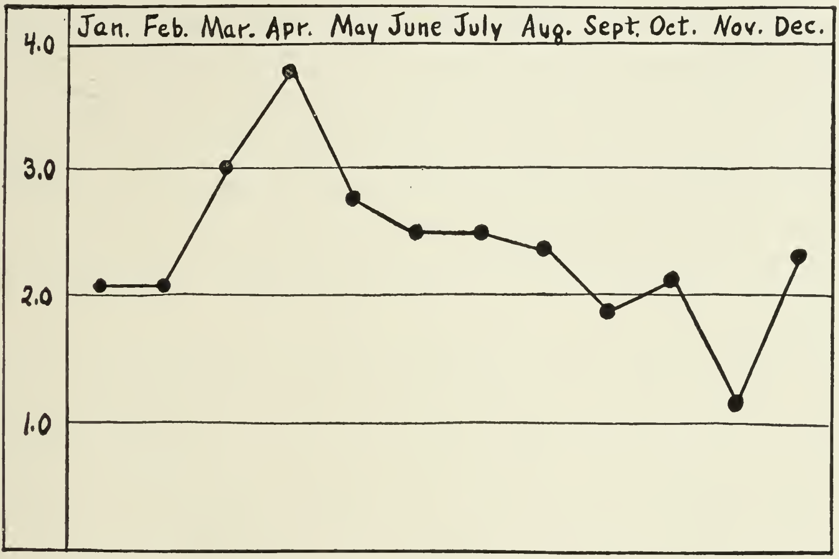

Fig. 489.—Graphic Chart Showing the Incidence of Eclampsia in the Various Months as Determined from the Records of the New York Lying-in Hospital (Harrar). The line shows the number of cases per 100 deliveries.

In most cases during the seizure the arterial pressure is markedly increased, the systolic pressure frequently rising well over 200 millimeters, while the diastolic shows a proportionate rise, although it sometimes is relatively higher than the systolic pressure. Very exceptionally no rise is noted, and on several occasions I have seen patients go through the eclamptic attack with a maximum pressure of 140 millimeters. The pulse is usually full and bounding, but in very severe cases it is weaker and more rapid, becoming more compressible and filiform with each succeeding convulsion. The temperature usually remains normal, but occasionally it rises to a very considerable height from the onset of the disease. An elevation to 104° or 105° F. is not unusual, and in one of my fatal cases it reached 109.5° F. just before the end. This complication is of very serious prognostic import; although, if the patient does not die, the temperature usually falls to normal within twenty-four hours after the cessation of the eclamptic seizure. As regards the cause of this elevation there is much discrepancy of opinion. Olshausen believed that the poison which causes the eclampsia also stimulates the thermal centers, while Zweifel held that the fever is of infectious origin. I incline to the former view, for in every such case, in which I examined the uterine lochia bacteriologically, negative results were obtained. On the other hand, if the fever persists for any great length of time after the convulsions have ceased, it is usually a manifestation of puerperal infection, as women suffering from the disease appear to be especially susceptible to bacterial invasion.

While the convulsions are by far the most striking clinical manifestations of eclampsia, and even give the disease its name, instances are occasionally met with in which they are absent, the patients dying in coma and presenting at autopsy the hepatic and renal lesions characteristic of the affection. Three such cases were reported by Schmorl, in 1902. I have seen several, two of which were recorded by Slemons, in 1907. Since then the condition has been more generally recognized, and was considered critically by Schickele, in 1917. In many instances the absence of convulsive attacks has led to an erroneous clinical diagnosis, the condition having been regarded as uremic coma, phosphorus poisoning, fulminating bacterial infection, Weil's disease, or acute yellow atrophy of the liver. In fact, a correct diagnosis can usually be established only at autopsy.

According as the disorder first appears before or during labor or in the first hours of the puerperium, it is designated as antepartum, intrapartum, or postpartum eclampsia. It is generally stated that the latter makes up about one-fifth of all cases; while there is a good deal of discussion as to whether the antepartum or intrapartum variety is the more common. From the consideration of 6519 cases collected from the literature, Hinselmann estimated the incidence of the three varieties at 26, 53 and 21 per cent, respectively. On the other hand, in 275 cases observed in our service up to March 1926, the incidence was 53, 25, and 22 per cent, respectively. In other words, in my material the antepartum variety occurred more than twice as frequently as the intrapartum variety—an opinion in which Eden and McPherson concur. I believe that Olshausen gave the correct reason for the discrepancy when he pointed out that many women fall in labor soon after the first convulsion, so that if the history is inaccurate the condition is designated as intrapartum.

Antepartum eclampsia may terminate in several ways. As a rule, labor sets in and a premature child is born spontaneously, or the uterus is emptied by operative procedures. Sometimes the patient dies undelivered. Lichtenstein has directed particular attention to the fact that labor does not always supervene, but that the woman may recover from the attack and give birth to a dead or macerated fœtus some time afterwards, or may even go on to term and bear a living child. In such circumstances, he designated the eclampsia as intercurrent, and, as early as 1911, had collected 120 such cases from the literature. With the increasing employment of conservative treatment, I see numerous examples of intercurrent eclampsia each year, and in the exceptional instances in which a week or more elapses between the convulsive attack and the birth of a livng child, the question arises as to what part the metabolic processes of the child played in the production of the disease. Olshausen and others have described as recurrent eclampsia cases in which the patients, after being perfectly well for a longer or shorter period, have a recurrence of the seizure, which may terminate in any one of the ways mentioned above.

If the attack occurs during labor, the pains usually increase in frequency and severity, so that the child will be born somewhat sooner than usual, after which the convulsions generally cease. On the other hand, in severe cases, or when there is some impediment causing dystocia, the patient may die underlivered, unless operative measures are undertaken.

In postpartum eclampsia the attack usually comes on soon after delivery, and recovery often occurs after a single convulsion. In other cases, however, the seizures follow one another in rapid succession, and frequently cause death. The general belief that postpartum eclampsia is comparatively benign, is correct only in so far as the case is mild, but in the severe cases the mortality is high, with the result that the death rate for all cases was 27, 25, and 18 per cent in the series observed by Lichtenstein, Olshausen, and myself, respectively.

A few instances have been reported in which convulsions did not appear until several weeks after the birth of the child. It can be safely assumed, as was pointed out by Van der Velde, that such conditions were not eclamptic at all, but were due to hysteria, uremia, or other causes.

Occasionally the onset is preceded by a distinct aura, but this is usually lacking. In rare instances the convulsion comes on without warning, but it is generally preceded for some days or even weeks by symptoms indicative of preëclampsia. As has been pointed out by Olshausen, severe epigastric pain, or a sensation as if the thorax were encircled by a tight girdle, is a frequent precursor of the seizure, and is a sign to which too much attention can hardly be paid.

The convulsions are always followed by unconsciousness. Moreover, the patient may not only not remember the attack itself, but even have no recollection of occurrences which had taken place several hours previous to it. This is a not altogether uncommon observation, and may sometimes have an important bearing from a medicolegal point of view. In about every twentieth case, according to Sioli, eclampsia is followed by an acute psychosis in which the patient may become very violent. The psychotic condition usually becomes manifest on the second or third day after delivery, and ordinarily is regarded as a result of the toxemia. The prognosis is excellent, except when the patient possesses a psychopathic tendency, or in the rare instances in which it follows a severe puerperal infection.

In rare instances, as the result of cerebral lesions incident to eclampsia, a *hemianopsia* may develop during the puerperium. More frequently the disturbed vision, which sometimes precedes the attack, is due to edema of the retina, which usually disappears spontaneously. Occasionally, hemorrhagic retinitis or detachment of the retina, is observed, but in other cases the visual disturbance is unattended by demonstrable changes in the retina or optic nerve, and is to be regarded as a manifestation of the general toxemia. As was indicated in the section on nephritic toxemia, albuminuric retinitis is a complication of chronic nephritis, but not of preëclampsia or eclampsia. In general, the prognosis of the ocular lesions accompanying eclampsia is surprisingly good, and many cases of incomplete detachment of the retina lead to no permanent impairment of vision.

In a small number of cases the patient becomes markedly jaundiced, either during or shortly after the convulsive seizure. This sign is of grave prognostic significance, indicates serious hepatic involvement, and should lead one to suspect the possible existence of acute yellow atrophy of the liver. At the same time, it is well to remember that the icterus may be due to causes not associated with the pregnant state.

The urine during the eclamptic seizure usually gives evidence of a marked renal insufficiency. It is invariably diminished in amount and occasionally entirely suppressed. On microscopical examination various types of casts are found in great abundance, although the hyaline and granular varieties predominate. Epithelial casts also occur, as well as isolated renal cells, while blood is nearly always present. Hemoglobinuria may also be observed.

Albuminuria is almost constantly present, and frequently is so pronounced that it is necessary to dilute the urine to several times its bulk before an accurate determination can be made by means of the Esbach tube. In the majority of severe cases this test shows the presence of at least 10 grams of albumin per liter (one per cent) during the acute stage of the disease, while in many instances much larger quantities are noted—sometimes as high as 30 or 40 grams. The albuminous precipitate is composed of both serum albumin and serum globulin, and in one instance, in which the relative amounts of each were determined, the latter was found to be 34 per cent. Wallis states that in eclampsia the ratio is 2 to 1, while in nephritis it is 6 to 1.

This high percentage output of albumin is only temporary, although the total daily excretion may remain high for some days. This is in part due to the fact that as recovery occurs the oliguria becomes replaced by polyuria, so that the same quantity of albumin in the greatly increased bulk of urine results in a marked lowering of the Esbach readings. Usually it falls to a fraction of one gram per liter within forty-eight hours after delivery, and completely disappears in the course of two or three weeks, unless the attack is followed by the development of chronic nephritis. Whether it is better to consider the percentage or the total daily output of albumin is not yet clear. In my experience the former seems of greater prognostic value, while, on the other hand, it might well be urged that a considerable total daily output gives a more accurate conception of the extent of depletion of the plasma proteins, which are apparently so essential. It is interesting to note that these high grades of albuminuria do not necessarily indicate the existence of profound renal lesions. This is proven by the rapidity with which the albumin completely disappears in patients who recover, as well as by the presence of only relatively mild degenerative processes in the kidneys of those who come to autopsy, and the latter is true even when the urine had contained casts of all kinds during life.

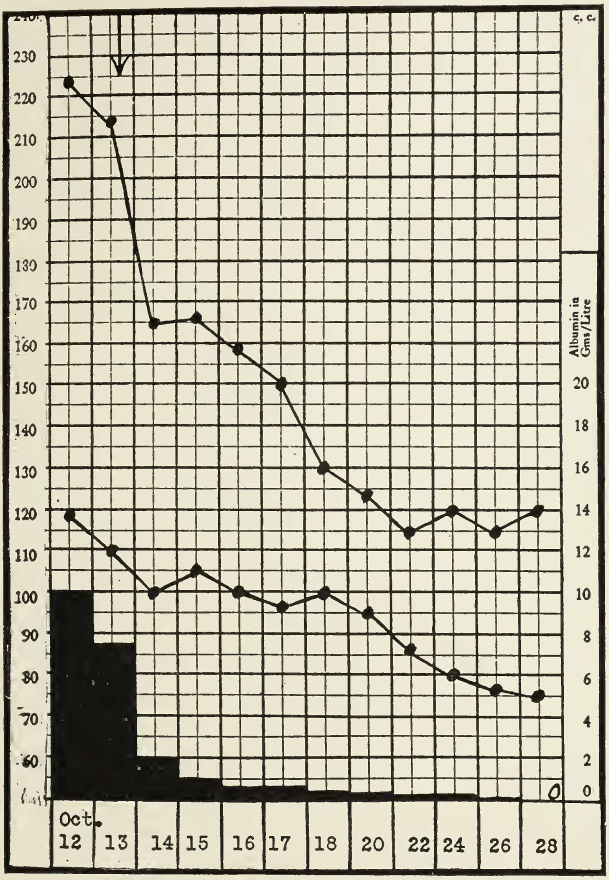

Fig. 490.—Behavior of Systolic and Diastolic Pressure and Albuminuria in Eclampsia.
Arrow indicates day of delivery.

There are no very significant alterations in the known chemical constituents of the urine, which cannot be well accounted for by the changes in the metabolic condition of the patient. As a result of the oliguria the total nitrogen output is low, and the urea nitrogen output disproportionately diminished. This is shown by the consideration of the ratio between the two $\left(\frac{\text{Urea N}}{\text{Total N}}\right)$ which is normally 80 per cent. whereas in 100 cases of eclampsia studied in our clinic, it was reduced to 66.2 per cent. The output of uric acid, creatinine, etc., is within normal limits, but the actual, as well as relative, output of ammonia is diminished during the attack, to rise slightly above the usual limits of recovery ensues. The urinary chlorides are unusually low during the attack, to be followed by a pronounced rise during the first days of convalescence, after which normal conditions become restored.

During convalescence the urine promptly returns to a normal condition. At the same time the increase in its quantity and nitrogenous content cannot be regarded as being entirely due to the elimination of materials, whose retention was supposed to have caused the disease, as we know that somewhat similar changes occur after normal labor, when the high nitrogen content must be attributed to the involution of the uterus and other puerperal changes. Although the albumin usually clears up rapidly, it frequently shows a slight increase when the patient is allowed a more liberal diet. On the other hand, its persistence for longer than a month indicates the existence of a chronic nephritis, which in most cases had antedated the eclamptic attack, but occasionally appears to have resulted from it.

Within the past few years a great amount of chemical work has been done upon the various constituents of the blood, in the hope that alterations in its constitution might throw light upon the nature of the toxemic process, but as yet little helpful information has been obtained, although such investigations have served to discredit certain theories which taught that eclampsia is due to the retention of endproducts or byproducts of metabolism. On the other hand, work in this clinic by Plass, and by Stander and his coworkers shows that such examinations are sometimes of help in diagnosis, and are frequently of great value in prognosis, although it must be admitted that in many instances the information obtained is scarcely commensurate with the trouble and expense involved. From a diagnostic point of view any great increase in the nonprotein nitrogen content should be regarded as indicating uremia rather than eclampsia.

During the six years ending May, 1929, Stander and his coworkers have made careful chemical studies in one hundred cases of eclampsia. In general, they found that the disease is rarely associated with nitrogenous retention in the blood, and that when the nonprotein nitrogen is increased in amount it is probably due to kidney damage incident to the eclamptic attack. The same holds true for the blood urea nitrogen. The outstanding features consist in an increase in the uric acid content and a decrease in the carbon dioxide combining power. The blood sugar may be normal, but is generally increased. There is a definite elevation in the amount of lactic acid, and but little change in creatine or creatinine. The blood chlorides are usually increased, particularly when marked edema is present. There is a slight elevation in the phosphorus-calcium ratio, due to an increase in the former rather than to a decrease in the latter. The relation of the blood colloids is disturbed, with an increase in globulin, euglobulin and fibrinogen at the expense of the albumin fraction. In other words, the most important changes occur in the uric acid, in the carbon dioxide combining power, and in the blood sugar.

While the increase in uric acid is not pathognomonic, it is, nevertheless, of considerable prognostic significance, as it averaged 5.6 milligrams in the patients who recovered, as contrasted with 7.6 milligrams in those who died. The diminution in the carbon dioxide combining power is of great interest and importance, as in over 30 per cent of our 100 patients it had fallen to 36 volumes per cent or less, reaching the extraordinary low figure of 12.4 volumes per cent in one of the fatal cases. Until 1929, the significance of such changes was not clear, but in that year Stander reported the results obtained by the electrometric determination of the hydrogen-ion concentration, or P_H, of the blood in eclampsia, and in certain severe cases found it to be so reduced as to be incompatible with life if it persisted for any length of time. In other words, he found a true acidosis, as indicated by a fall of the P_H to the neighborhood of 7 in some of the very severe cases.

In our series of cases, the sugar content of the blood was generally increased, the average for the one hundred cases being 93.5 milligrams per 100 cubic centimeters (taking 60 milligrams as normal). The significance of this increase is not clear, but the fact is of great interest, as it tends to discredit the belief of Titus and his associates that the convulsions are a manifestation of an absolute or relative hypoglycemia. Work just completed in our laboratory by Eastman substantiates the statement of Plass that during normal pregnancy the albumin-globulin ratio of the blood plasma is disturbed, with a relative increase in the globulin fraction, and indicates that such changes are accentuated in toxemia. He did not find the changes as pronounced as claimed by Seitz, Eufinger and his coworkers, and therefore does not share their belief that the essential disturbance consists in what they term a "dyscolloidosis."

Attention should also be directed to the observation of Plass in this clinic that during the first few days following the subsidence of the eclamptic attack the nonprotein constituents of the whole blood or plasma rapidly increase in amount, and then promptly return to normal. While the explanation for this phenomenon is not clear, it has been suggested that preceding the attack those materials had been pathologically stored in the body tissues, whence they were abstracted during convalescence. Evidence in favor of such a supposition is afforded by the fact that the increases are most striking in patients with marked edema. That such changes are not due to an increased concentration of the blood is shown by the fact that determination of the total plasma protein indicates that increased hydremia or hydroplasmia immediately follows any clinical improvement on the part of the patient.

That our knowledge of the changes taking place in the blood during eclampsia is still very imperfect is shown by the observation of Küstner, that the injection of eclamptic blood into frogs leads to an intense melanophore reaction. As a similar reaction follows the injection of pituitrin, he is inclined to believe that increased amounts of that substance are circulating in the blood in this disease.

Pathology.—After Rayer and Lever had demonstrated the presence of albumin in the urine of women suffering from eclampsia, it was generally believed that the fundamental pathological lesion was a nephritis, and for a long time the condition was considered to be identical with uremia.

This view, however, was gradually abandoned when it was found that only a small proportion of women suffering from chronic nephritis developed eclampsia; and still further modifications became necessary after it had been shown that albuminuria is sometimes absent at the time of the eclamptic attack, Schroeder, Ingerslev, and Charpentier having collected respectively 62, 112, and 143 such cases from the literature. The absence of albumin, however, does not necessarily disprove the renal origin of the disease, since Van der Velde has reported two instances of eclampsia in which the kidneys were markedly diseased, notwithstanding the fact that albumin was not demonstrable.

For the most part, autopsy will reveal the presence of renal changes, which may be marked in some and only slight in other cases. According to Fahr, with whom I agree, the lesion is essentially a glomerulonephrosis—that is, it consists of degenerative changes in the vessels and epithelium of the glomeruli, associated with similar changes of varying intensity in the epithelium of the convoluted tubules. There are no signs of inflammatory or atrophic change unless the process has been engrafted upon a preëxisting disease. In other words, the evidence indicates that the renal lesions are the result, and not the cause, of the toxemic process. Prutz found that the kidneys were involved in all but 7 out of 368 autopsies collected from the literature, in which the description was sufficiently accurate to be of value. Notwithstanding such findings, however, he concluded that "we are not justified in considering the renal lesions as the anatomical substratum of eclampsia, for in many instances they are too insignificant; accordingly, it must remain a question whether they are not purely secondary in the greater proportion of the cases."

This view is also indorsed by Lubarsch, Schmorl, Bar and most other observers. On the other hand, Pels Leusden, Winckler, Knapp and other writers are inclined to consider the renal changes as the essential lesion of the disease. It should be noted that very extensive changes are occasionally observed, and Jardine and Kennedy, Rolleston, Westman and others have reported instances in which the entire cortex of the kidney had undergone complete and symmetrical necrosis.

Halbertsma, in 1876, pointed out that the ureters were often enlarged and dilated, and was inclined to attribute the production of the disease to this condition. Prutz noted a similar finding 37 times in his analysis of 500 autopsies, and Lichtenstein in 15 out of 50 autopsies. As this incidence is no greater than is noted in normal pregnancy, it is evident that the abnormality cannot stand in an etiological relation to eclampsia.

Although Jürgens and Klebs, in 1886, had pointed out the existence of a *hemorrhagic hepatitis* in certain cases of eclampsia, it remained for Pilliet, in

1888, to direct our attention to characteristic hemorrhagic lesions in the eclamptic liver. His work was abundantly confirmed by Schmorl, in 1893, who stated that he had found in every case lesions which he held to be more characteristic than those observed in the kidneys. These consist of irregularly shaped, reddish or whitish areas scattered through the entire organ and originating near the smaller portal vessels. Ordinarily they are readily seen with the naked eye, and on section give the liver a striking mottled appearance. Under the microscope they are recognized as areas of necrosis, involving the periphery of the individual lobules and the portal spaces, in which blood cells may or may not be present. In certain cases, the degenerative changes are slight, when the areas involved are in great part made up of ectatic capillaries. Schmorl attributed the formation of the necrotic areas to degenerative changes following thrombotic processes in the smaller portal vessels, and considered that their presence justified the diagnosis of eclampsia without further knowledge of the history of the case

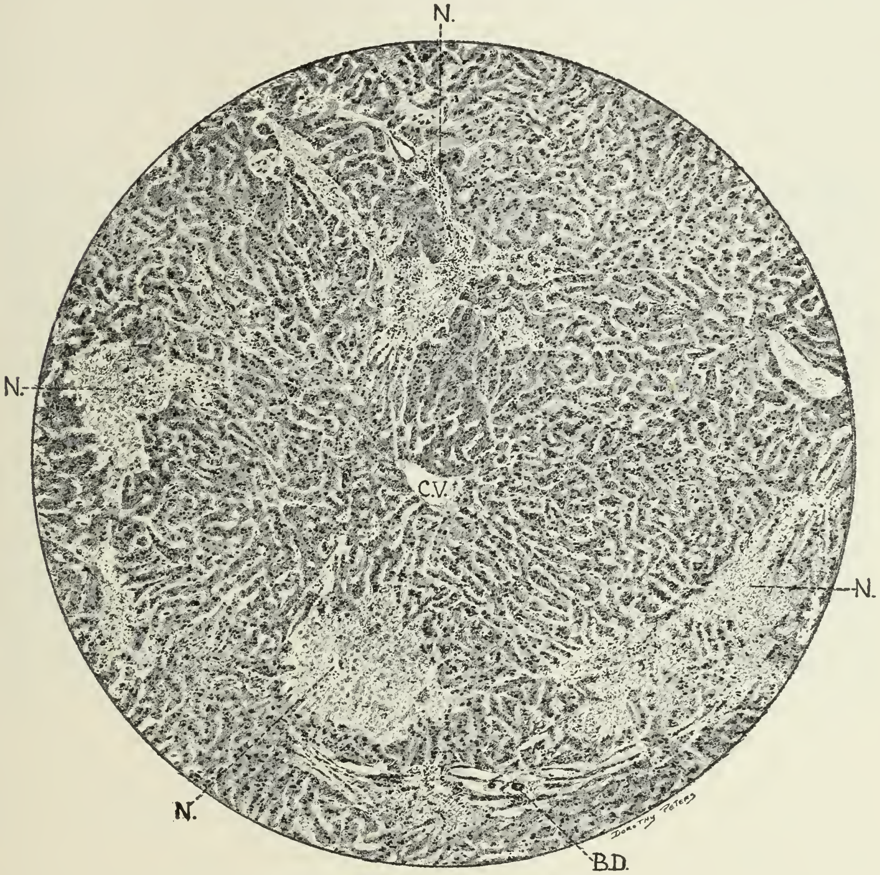

FIG. 491.—ECLAMPTIC LIVER. × 50.
B. D., bile duct; *C. V.*, central vein; *N.*, periportal necroses.

(Fig. 491). Flexner has shown that the earliest stages in the thrombotic process are due to the agglutination of red blood corpuscles.

These findings were soon confirmed by subsequent observers, and Schmorl, in 1902, observed them in 71 out of 73 autopsies, while in the two negative cases there was a fresh thrombosis of the portal vein. I have been able to demonstrate similar lesions in most of the eclamptic livers which I have examined, and consider that they are absolutely characteristic; since, as far as we know at present, they do not occur in any other disease. The subject has been thoroughly reviewed by Heinrichsdorff, Ceelen, Konstantinowitsch, and Fahr. While generally indorsing Schmorl's teaching, all of them hold that such lesions are not always present, but are pathognomonic when observed.

Fähreus, in 1929, reviewed our knowledge concerning the significance of the sedimentation time of the red blood cells. He had pointed out years previously that it was definitely increased in eclampsia, and in the present communication he shows that it is due to a peculiar clumping of the red cells, which he believes must favor thrombosis in general, and the production of the characteristic hepatic lesions of eclampsia in particular. Dieckmann, in 1929, claimed that he was able to produce similar lesions in nonpregnant dogs by the injection of fibrinogen, but the illustrations accompanying his publication are too defective to permit an expression of opinion.

Several observers have described the presence of hematomata of varying size, just beneath the capsule of the liver, Prutz having recorded a fatal intraperitioneal hemorrhage from the rupture of such a structure.

Varying statements have been made concerning the pathological findings in the brain—edema, hyperemia, anemia, thrombosis, and apoplexy being described as the main lesions. Prutz noted edema in 42 per cent, hyperemia in 35 per cent, and apoplexy in 13 per cent, while the brain was apparently normal in only 10 per cent of his cases. Schmorl, in 58 out of 65 autopsies, noted the presence of thrombi in the smaller cerebral vessels, and regarded them as the cause of the small areas of necrosis which are so often observed. Finally, Sioli, and DeCrinis have noted perivascular lesions, and particularly ischemic and degenerative changes in the ganglionic cells, which they consider are the direct result of the toxemia.

In most cases of eclampsia the heart is more or less involved, and was perfectly normal in only 8 out of 102 autopsies analyzed by Pollak. According to Schmorl, the changes usually consist in degenerative processes in the myocardium, which are generally regarded as being due to eclampsia, though at times they may be attributed to the use of chloroform in its treatment.

Following Schmorl, all investigators have demonstrated in the pulmonary capillaries the presence of giant cells, which they identified with masses of placental ectoderm. Schmorl originally believed that their presence explained the production of the thrombotic processes observed in various organs. Such views are no longer held, as such findings are generally recognized as being due to the deportation of fœtal elements, which is regarded as a physiological occurrence in all pregnancies.

In patients who have died several days after the cessation of the convulsions, in addition to the lesions just described, bronchopneumonia or the various evidences of puerperal infection are frequently noted.

It is apparent, therefore, that the main lesions in eclampsia are found in the liver, kidneys, heart, and brain; but in view of the marked discrepancy in the statements of the various authors concerning their relative frequency and importance, it would seem, with the exception of the lesions in the liver, that the anatomical changes are not constant or characteristic. Accordingly, it must be assumed that the essential feature in the morbid process is the circulation of some as yet unknown "toxic" substance in the blood, which may give rise to lesions of varying intensity in the several organs.

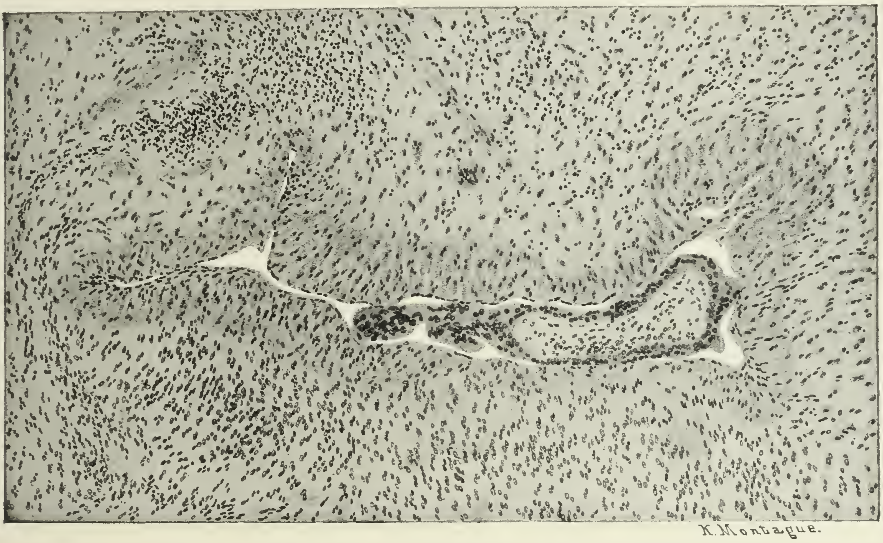

FIG. 492.—PLACENTAL GIANT CELL AND CHORIONIC VILLUS IN BLOOD VESSEL OF TUBE WALL SOME DISTANCE FROM PLACENTAL SITE. × 80.

Etiology.—So many hypotheses have been advanced concerning the etiology of eclampsia that Zweifel has aptly designated it as "the disease of theories." Unfortunately, exact knowledge is still lacking.

From the earliest periods it was considered as a disorder of the nervous system peculiar to pregnancy. This conception is no longer entertained, though there is no doubt that the nervous system is in a condition of less stable equilibrium during pregnancy than at other times. This has been demonstrated by Blumreich and Zuntz, who showed that convulsions could be produced by the application to the cerebral cortex of far smaller quantities of powdered creatinine in pregnant than in nonpregnant animals.

Following the discovery by Lever, in 1843, that the urine of eclamptic patients contained albumin, the process was identified with Bright's disease, which had been described a few years previously. From then onward, but more particularly after 1880, the etiology of eclampsia has been industriously studied, and every important contribution to medical thought has been applied to its solution. Up to the present, however, none of the explanations advanced has stood the test of criticism, and we are still ignorant of its actual cause. Nevertheless, this great expenditure of effort has not been wasted, since it has led to the elimination of many theories, and has thus prepared the way for the eventual discovery of the ultimate cause of the disease.

In order for any theory to be regarded as acceptable, it must explain satisfactorily certain pathological and clinical facts, of which the following may be mentioned: A. The genesis of the characteristic hepatic lesions. B. The predisposing influence of primiparity, multiple pregnancy and hydramnios. C. That the disease is more common in northern countries than in the tropics. D. That its incidence increases as pregnancy approaches term. E. That marked edema is usually a favorable sign, while its absence adds to the gravity of the prognosis. F. That repeated eclampsia rarely occurs, whereas chronic nephritis gives rise to increasingly serious trouble in each succeeding pregnancy. G. That intrauterine death of the fœtus is usually followed by improvement. H. That a milk diet, which is high in protein and mineral constituents, is as efficacious as one low in protein and free of salt.

Some idea of the scope of the researches may be gained by considering the following twelve headings:

I. Uremia
II. Bacterial origin
III. Auto-intoxication
IV. Biological reactions
V. Entrance of fœtal elements into the maternal circulation
VI. Fœtal metabolic products
VII. Placental decomposition products
VIII. Alterations in maternal metabolism
IX. Endocrine disturbances
X. Mammary toxemia
XI. Effect of dietary alterations
XII. Physicochemical changes

I. *Uremia.*—It has already been mentioned that following the appearance of Lever's article, eclampsia was identified with uremia, and that view was slowly abandoned only after it had been demonstrated that the lesions of eclampsia and of chronic nephritis had little in common. Consequently, it is now recognized that the two processes are quite distinct, but at the same time it must be remembered that clinical differentiation is sometimes difficult, and occasionally impossible, more particularly for the reason that true eclampsia may become engrafted upon an old nephritic process.

II. *Bacterial Origin.*—Doléris, and Rodet of Lyons, in 1884, suggested bacterial invasion as a possible etiological factor, but adduced no evidence in support of such a view. The first investigations were made by Doléris, in 1885, and following him many observers reported that they had cultivated various bacteria from the urine, blood, and tissues of eclamptic women, but their findings were so contradictory as to be of little value. On the other hand, all later investigators working with modern technical methods have obtained negative results, so that it is generally agreed that eclampsia is not of bacterial origin. Notwithstanding, this general consensus of expert opinion, many clinicians will express a vague belief in the infectious origin of the disease, as they hold that it would best account for certain of its clinical peculiarities.

According to Talbot and LaVake, the existence of focal infections in the tonsils, teeth and other organs, plays an important part in the production of the disease, and Bugbee holds that infections of the urinary tract do likewise. While many eclamptic women doubtless harbor such foci of infection, no satisfactory evidence has been adduced to indicate that they play any essential part in its etiology.

III. *Auto-intoxication.*—The work of Bouchard upon auto-intoxication led Rivière to put forward the theory that eclampsia was an auto-intoxication resulting from the heaping up of some substance in the system during pregnancy, holding that its presence was indicated by an increase in the toxicity of the blood serum and by a decrease in that of the urine. This conception was placed upon an apparently secure foundation by the work of Chamberlent, Tarnier and their students, who showed that the urine of women suffering from eclampsia, or just about to be attacked by it, when injected into the circulation of animals was less toxic than normal urine, while the toxicity of the blood serum was definitely increased. They concluded, therefore, that some poisonous substance, which should have been excreted by the kidneys, was accumulating in the blood serum, thereby giving rise to the hepatic and renal lesions, which still further accentuated the condition.

The earlier work along these lines was in great part confirmatory, but, when it was repeated with perfected technic and proper control, it became evident that it was erroneous, and it is now generally admitted that satisfactory evidence has not been adduced in support of the view that a "toxin" in the blood serum is the cause of the disease, more particularly as Obata, in 1919, was unable to detect any increased toxicity in his animal experiments.

IV. *Biological Reactions.*—Following Schmorl's suggestion that the characteristic hepatic lesions were possibly due to the entrance of placental cells into the maternal circulation, the problem was approached from the biological side, and the phenomena of agglutination and hemolysis, and later those of anaphylaxis, were studied in the hope that they might throw light upon the subject.

(*a*) AGGLUTINATION AND HEMOLYSIS.—After Flexner had shown that the agglutination of red blood corpuscles was the immediate cause of the thrombosis which initiates the characteristic periportal necroses, and Pearce had demonstrated that similar thrombi could be produced experimentally by the injection of hemagglutinative sera, numerous attempts were made to associate such phenomena with the etiology of eclampsia. Leith Murray believed that, while agglutination leads to necrosis, hemolysis merely results in degenerative changes, and that the existence of a special endothelial toxin—hemorrhagin—must be invoked in order to explain the production of hemorrhagic lesions. Accordingly, he considered that the toxemias of pregnancy are attributable to the action of a triple toxin, and that the lesions and symptoms will vary according to which one of the three factors predominate. While ingenious and interesting, this theory has not been substantiated.

Following the suggestion of Dienst, in 1905, that fœtal blood cells might gain access to the maternal circulation and there give rise to agglutination, various investigators have expressed more or less similar views. Gräfenberg believes that the essential feature of the eclamptic placenta consists of such engorgement of the fœtal vessels that lesions of continuity occur with the escape of fœtal blood into the intervillous spaces. He may be correct, but in the histological examination of many thousands of normal and of considerable numbers of eclamptic placentæ, I have never been able to satisfy myself that it really occurs, and therefore I am skeptical concerning the correctness of any theory which postulates it.

Strange to say, investigations along somewhat similar lines carried out in our clinic by McQuarrie and by Allen led to diametrically opposite results. Each studied the question of iso-agglutination of the fœtal and maternal blood; the former reported that the two bloods were incompatible many times more frequently when the mother presented signs of toxemia, while the latter in a much larger series of cases found that it made very little difference whether the pregnancy was normal, or was complicated by toxemia or by actual eclampsia. Allen's work was based upon the study of 400 pregnant women, including 28 with actual eclampsia, and to my mind effectually disposes of the theory. Furthermore, comparison between his results and those of McQuarrie well illustrates the fallacy of drawing conclusions from too small a number of observations.

(*b*) Anaphylaxis.—Rosenau and Anderson, in 1908, suggested that eclampsia might represent an anaphylactic reaction. This idea was still further elaborated by Thies and Lockeman, and by Gräfenberg, who, after an extensive series of experiments, held that the mother was sensitized during pregnancy by small quantities of fœtal protein, and would go into anaphylactic shock if a quantity of fœtal blood were suddenly introduced into her circulation. They identified the condition with eclampsia, and claimed that the liver and kidneys presented characteristic lesions. On the other hand, the researches of Johnstone, Murray, E. Zweifel and others have led to negative results, so that it is probable that Rosenau's findings must be attributed to the introduction of the products of placental autolysis.

A somewhat similar theory has been advanced by Mayer, who assumes that following coitus certain elements of the sperm are normally absorbed through the vaginal or uterine mucosa and thus sensitize the woman, and that its frequent repetition might lead to a pseudo-anaphylactic reaction, namely toxemia or eclampsia. As opportunity for sexual intercourse was greatly restricted during the World War, he suggests that the striking reduction of the incidence of eclampsia which occurred in Central Europe might be attributed to it. Such an hypothesis seems fanciful, more particularly since the facts can be explained more rationally upon the basis of the dietary changes incident to the food blockade, as well as by the observation that women who have become pregnant after a single coitus are not immune to the eclampsia.

V. *Entrance of Fœtal Elements into the Maternal Circulation.*—Veit, in 1902, promulgated an hypothesis along the lines of Ehrlich's side chain theory, which for a time bade fair to solve the problem. Notwithstanding its failure to do so, his work has served to direct attention to the "biological" aspects of the problem and has stimulated a large amount of investigation. This theory was based upon the fact that at all periods of pregnancy varying amounts of fœtal ectoderm, and even fragments of chorionic villi, are constantly gaining access to the maternal circulation—the process being designated as "deportation." Veit contended that such elements give rise to a poison—syncytiotoxin, which is normally rendered innocuous by a supposititious antibody, syncytiolysine, which develops in the maternal serum. If, however, for any reason, the former is present in quantities too great to be neutralized, or if the elaboration of the latter is interfered with, symptoms of poisoning result and eclampsia eventually follows.

He considered that the correctness of the theory was established when he found that the injection of an emulsion of human placenta into the peritoneal cavity of rabbits was followed by albuminuria and sometimes by death. In drawing his conclusions, however, he overlooked the fact that similar results might follow the introduction of any heterogeneous animal tissue, and also that nature performs a much more ideal experiment whenever the rupture of a tubal pregnancy leads to the extrusion of the ovum into the peritoneal cavity. The fact that eclampsia does not supervene under such conditions speaks strongly against the correctness of this view. Ascoli, on the other hand, held that the disease was due to an excessive production of syncytiolysine.

VI. *Fœtal Metabolic Products.*—Fehling, in 1899, and Dienst, in 1902, advanced the theory that eclampsia is due to intoxication by products of the fœtal metabolism. The advocates of this view lay great stress upon the fact that death of the fœtus *in utero* is in many cases promptly followed by cessation of the convulsions and the recovery of the patient, but particularly upon the fact that the children of eclamptic mothers occasionally develop convulsions shortly after birth and present characteristic hepatic lesions at autopsy. Cases of this latter type were collected and critically considered in Dienst's monograph.

Observations of neither type, however, can be relied upon to support the contention that eclampsia is fœtal in origin, except in so far as it must be conceded that the development of the fœtus is the essential function of pregnancy, and that its death must lead to radical changes in the entire process. On the other hand, the presence of lesions in the fœtus is noted so rarely that it would seem more rational to attribute them to the action of substances derived from the mother, which had passed through the placental filter, than to regard them as a manifestation of a primary fœtal disturbance. Furthermore, the occurrence of intercurrent eclampsia, in which the patient recovers from the convulsive seizure and later gives birth to a normal living child, speaks against such a view.

The argument that the fœtal origin of the disease is disproved by the occasional association of eclampsia with hydatidiform mole does not appear convincing, as it is conceivable that the metabolic processes incident to the continued growth of the chorionic villi may not differ materially from those of the normal fœtus. However this may be, little is said at present concerning the fœtal origin of eclampsia, except by the exponents of the agglutination theory, and it has been intimated above that it need not be considered seriously.

VII. *Placental Decomposition Products.*—(*a*) PLACENTAL ENDOTOXINS.—Following Veit's theory numerous investigators, including Liepmann, Freund, and Guggisberg, have attempted to prove that eclampsia is due to endotoxins produced by the normally situated syncytial cells. They found that the injection into experimental animals of emulsions or extracts of placental tissue were usually followed by rapid death and sometimes by convulsions, but at autopsy the lesions were not characteristic. Furthermore, Lichtenstein demonstrated that the results were in great part mechanical, and that large quantities of such preparations could be injected with impunity provided all suspended particles had been previously removed by filtration. As subsequent writers have confirmed his observations, it may be stated that there is no evidence to indicate that eclampsia can be produced by normal placental tissue, provided suitable precautions have been taken in the preparation of the material used for experimentation.

(*b*) AUTOLYSIS.—Upon repeating Rosenau's work, Leith Murray, and Johnstone proved that his results were dependent upon the fact that he had autolyzed the placentæ for several hours before utilizing them for injection into animals. Not only did they demonstrate that unautolyzed placental tissue failed to give any reaction, but they were able to reproduce the toxic symptoms, which he described by the use of extracts prepared from autolyzed liver. How difficult it is to eliminate from experimental work the effects of autolysis is evident from the contention of Dryfuss that it may occur even while the placenta is still functioning in situ.

The toxicity of the autolytic products of the placenta was utilized by Young in several communications concerning the origin of eclampsia. He emphasizes the association of toxemia with infarct formation, and holds that the clinical symptoms are due to autolytic products, which have originated *intra vitam.* In a communication prepared in collaboration with D. A. Miller, in 1921, he states that the failure to detect placental infarction in many cases of fulminating eclampsia is due to the fact that the changes are ultramicroscopic, but yet are sufficient to flood the patient with toxic autolytic products.

The association of red infarct formation with severe nephritic toxemia has long been known. It likewise occurs in the eclamptic placenta, but scarcely more frequently than in normal pregnancy. For years it has been my custom to cut into one-centimeter strips all placentæ coming from toxemic and eclamptic patients, and while their study reveals the presence of all types of infarcts somewhat more frequently than in normal pregnancy, I have not been able to convince myself that any characteristic change occurs, so that whatever gross lesions one may detect should be regarded as accidental or coincidental, but in no way connected with the causation of eclampsia. McNally and Dieckmann, as well as Hofbauer, hold the same views. I have already expressed my lack of accord with Gräfenberg concerning the significance of vascular changes in the placenta, nor can I agree with him that any excessive proliferation of placental ectoderm occurs during the course of the disease.

On the other hand, Cruickshank, Hewitt and Cooper hold that eclampsia is due "to some form of intoxication due to the breakdown of products of placental tissue, probably some of the higher products of protein katabolism," but they advance no serious proof in support of their belief. In the same way, Hofbauer considers that the continual breaking down of placental ectoderm might afford a plausible explanation for the production of histamine, which he holds may play an etiological rôle. In general, it may be said that while it is very easy to theorize concerning the part which the placenta might play, it is extraordinarily difficult to adduce conclusive proof. At the same time, it must be admitted that the placenta may well play a part, as the recent investigations concerning "folliculin" indicate that that substance either originates in or is stored by the placental ectoderm, so that some relatively trifling aberration in its function might well lead to profound disturbances.

(*c*) Lipoids.—The placenta has been analyzed by various investigators in the attempt to discover some substance which might produce toxic symptoms, but in general the results have not been encouraging. Considerable attention has been paid to its lipoid constituents, and various fatty substances have been isolated. For example, Freund and Mohr considered that they had solved the problem of hemolysis when they isolated oleic acid or sodium oleate, but it is now generally believed that these substances are merely derived from the fat normally present in the placenta.

Leith Murray showed that eclamptic placentæ contained larger amounts of soluble lipoids than normal organs, and held that such substances possessed marked hemolytic properties. He failed, however, in isolating a specific compound. Furthermore, Schönfeld, in 1921, claimed to have isolated a strong convulsant poison from the alcohol-acetone-glycerine extract of normal placentæ. He considers that it produces lesions similar to those occurring in eclampsia, but, from his description, this seems doubtful.

VIII. *Alterations in Maternal Metabolism.*—The first metabolic hypothesis was advanced by Spiegelberg who, in 1870, suggested that the circulation of ammonium carbonate in the blood was responsible for the seizures. Chemical examination having failed to substantiate the statement, it was soon abandoned.

It is, however, of historical interest, as it represents the first of a long series of attempts to correlate the manifestations of the disease with disturbed metabolism. Some years later, Ludwig and Savor considered the offending product to be carbamic acid, which they held was formed because of the inability of the liver to complete the synthesis of urea.

(*a*) General Metabolism.—Satisfactory metabolic studies have not as yet been made on account of the great difficulty in making total collections in eclamptic patients, but from numerous investigations it is evident that the metabolism is seriously disturbed. The earlier workers, who dealt entirely with the percentage composition of the urine, demonstrated that the urea accounted for an unusually small proportion of the total nitrogen—the so-called rapport azoturique, while the percentages for amino-acids, creatinine, uric acid, ammonia, and rest nitrogen were increased. As a result, the theories of suboxidation and imperfect desamidization were expounded and for a time were generally accepted, but with increasing biochemical knowledge they have in great part yielded to other ideas.

Zweifel attempted to find some imperfectly oxidized body in the blood, and isolated considerable quantities of sarcolactic acid, which has been confirmed by all subsequent observers. Stander found that it is greatly increased during the attack, and is inclined to regard it as a result rather than the cause of the convulsions. Reference has already been made to the decrease in the carbon dioxide combining power and its significance.

The lowered urea output in the urine was regarded as an indication that the liver was not properly fulfilling its function as the chief urea-forming organ of the body, and consequently it was assumed that poisonous, incompletely oxidized substances must be circulating in the blood. In addition, it was believed that the liver was incapable of fulfilling its detoxifying function. All of these assumptions are probably incorrect, as animal experimentation has shown that much more extensive destruction of liver tissue than is noted in eclampsia must occur before these functions become seriously impaired.

The increased percentage output of the amino-acid has likewise been utilized to support the theory that the liver is functioning imperfectly. Van Slyke and Losee, however, have demonstrated that the excretion of these substances is within normal limits, and they were also unable to detect any increase in their amount in the blood, although such increases occur in acute hepatic degeneration, as represented by acute yellow atrophy of the liver and chloroform poisoning. On the other hand, the increased percentage of undetermined, or rest, nitrogen has remained unexplained, notwithstanding repeated efforts to discover the presence of some unusual nitrogen-containing body.

As has been indicated, the urea output, which is greatly diminished during the acute stages of the disease, increases rapidly after delivery and is excreted in several times the normal amount. Sikes attributed this to an accumulation of precursors of urea in the system, while Slemons insists that it is due to involution of the uterus. Plass rightly holds that the excess, over the normal puerperal output, must be regarded as proof that an actual retention had taken place in the tissues.

According to Wells, changes in the sulphur metabolism also indicate that the body oxidations are not proceeding at the normal rate. This is evidenced by the fact that a greater amount than usual of sulphur is eliminated in unoxidized form, as compared with sulphur dioxide.

Chloride retention has been emphasized by Zinsser, and Büttner, who have shown that the elimination of chlorides is decreased during the eclamptic attack, and suddenly increases as improvement occurs. According to Zangemeister, this is associated with an increased percentage of plasma chlorides and with a hydroplasmia, which he regards as the essential change.

(*b*) BLOOD CHANGES.—Reference has already been made to the changes occurring in the blood of eclamptic patients, which usually consists in a marked increase in the uric acid and lactic acid content, in a less striking increase in the blood sugar, and a definite decrease in the carbon dioxide combining power, without any indication of retention of nonprotein nitrogen such as occurs so frequently in nephritic conditions. Furthermore, it was indicated that such changes must be regarded as secondary to the disease and as in no way explaining its etiology.

In view of the fact that a low blood calcium content is recognized as an important factor in bringing about increased nervous irritability—such as tetany, its behavior in normal pregnancy, and especially in eclampsia, has been studied. Kehrer and others have found that it falls below the usual limits in normal pregnancy, and is still further decreased in eclampsia. Plass, in our service, was able to confirm the first observation, but not the second, and considers the former a result of the hydroplasmia which characterizes normal pregnancy and sometimes becomes exaggerated in toxemic patients presenting marked edema. Stander and his associates also hold that the total amount of calcium is not altered, but that the calcium-phosphorus ratio is definitely lowered, as the result of an increase in the inorganic phosphorus.

(*c*) FERMENTS.—Schmorl originally suggested that the extensive thrombosis accompanying the disease might be due to the action of fibrin ferment (thrombin). This view has been especially advocated by Dienst, who holds that an increase in fibrin ferment, together with a higher fibrinogen and an abnormally low antithrombin content of the plasma, can account for all the observed phenomena. He believes that unusually large amounts of thrombin are produced in the placenta from leukocytes, and, as the diseased liver can no longer produce the necessary antithrombin, intravascular coagulation results. In 1927, he gave a good recapitulation of his views, and attempted to bring them into accord with those of others. The increase in the amount of fibrin ferment is capable of proof, and it has already been mentioned that Dieckmann claims to be able to produce eclampsia-like liver lesions in dogs by the injection of tissue fibrinogen.

It has been suggested that steapsine or lipase may have some etiological significance, but the evidence at present available indicates that their increase is secondary to the liver necrosis. Whipple has shown that the latter is definitely increased in experimentally produced liver necrosis, and that in eclampsia the degree of liver injury, as determined at autopsy, is closely paralleled by the increase in the blood lipase.

(*d*) Physical Changes in the Blood.—Füth and Krönig, and other observers have directed attention to an increase in the viscosity of the blood of pregnant women, which becomes accentuated in eclampsia, while Abderhalden, Fähraeus and others have shown that in freshly drawn eclamptic blood the red cells sediment more rapidly than usual. These phenomena have been variously interpreted, and it has been assumed that they may be concerned in the production of the initial thrombosis in the parenchymatous organs. However this may be, it seems safe to regard such changes as secondary to some more fundamental alteration.

IX. *Endocrine Disturbances.*—As soon as the importance of the glands of internal secretion was appreciated, it became evident that their functions are so altered during pregnancy that a new endocrine balance is probably established, and many attempts have been made to connect them with the various types of toxemia, but thus far nothing definite has been elicited.

After it had been established that the thyroid gland undergoes physiological hypertrophy during pregnancy, Lange and others suggested that its absence might predispose to toxemia. Nicholson, Ward and others soon put the suggestion into practice and recommended the administration of thyroid extract in the treatment of preëclamptic toxemia and eclampsia. Notwithstanding a considerable amount of work along such lines, the consensus of opinion is that abnormalities in the thyroid secretion play no part in the causation of eclampsia, and that its treatment by thyroid extract is useless.

Vassale and Zangfrongini ascribed a similar function to the parathyroid glands. It is now generally recognized that insufficient secretion on their part leads to the production of tetany, but not to eclampsia. Furthermore, at autopsy upon patients dying from the latter disease, no lesions can be discovered in the parathyroids. Consequently, Seitz must be correct in holding that they are in no way concerned in its production, and that treatment by means of parathyroid extract is irrational.

Our constantly increasing knowledge of the interrelations between the hypophysis and the generative function, and more particularly with the activity of the ovaries, brings well within the range of possibility that the cause of eclampsia may be connected with abnormal functioning of that gland, and makes less improbable the suggestion of Hofbauer that the cause of eclampsia is associated with hyperfunction of the hypophysis and adrenals resulting from a deficient secretion on the part of the ovaries. As yet, no proof has been advanced in support of any of these theories, and it is likely that it will continue to be lacking until our knwledge of such relations becomes much more precise. Finally, it might be mentioned that even the reticulo-endothelial system has been brought under contribution by Lundwall and others, and again without any material proof.

X. *Mammary Toxemia.*—Sellheim, in 1910, suggested the possibility that eclampsia might be due to toxins elaborated in the mammary glands, basing the suggestion upon the supposed similarity between the parturient paresis of cattle and human eclampsia, and he even amputated the breasts from a patient in whom eclampsia had proved refractory to other treatment.

Two years later Healy and Kastle stated that they could produce eclampsia experimentally by injecting into the peritoneal cavity of guinea-pigs small quantities of colostrum obtained from cows suffering from parturient paresis. At autopsy they found renal and hepatic lesions, which they considered suggestive of those observed in eclampsia. Their work has not been confirmed and I imagine will not be, as the investigations of Widmark and Carlens prove that parturient paresis has no connection with eclampsia, and is due to a sudden hypoglycemia coincident with the inauguration of lactation in cattle.

In any event parturient paresis is an interesting disease, which deserves more extended study. As is well known, it occurs in well-nourished cows shortly after labor, and formerly almost always ended in death; while now recovery almost universally follows the injection of air into the udders. It is characterized by paralysis, coma, convulsions, albuminuria, the presence of casts, and by a pronounced change in the nitrogenous partition. Owing to the fact that it is now rarely followed by death, little is known concerning its pathology. The reader is referred to the article of Prentiss Willson for information concerning possible relations between it and eclampsia.

XI. *Dietary Alterations.*—The startling reduction in the incidence of eclampsia in Central Europe during the World War, with return to the prewar frequency after its conclusion, has led to some interesting speculation concerning the origin of the disease. The articles of Ruge, Warnekros, Gessner, Varo, Buiz and others show that the reduction was most pronounced in the cities, and was minimal, or lacking, in the open country. They explained the difference by assuming that effect of the food blockade was most felt in the cities, whereas in the country the farmers took care that the needs of their families were supplied before disposing of their surplus stock. As the lack was greatest in meats and fats, the diet was restricted so far as possible to food of vegetable origin; consequently, the relative disappearance of eclampsia was generally attributed to this restriction, and attention was directed to the conditions prevailing in tropical countries in which eclampsia occurs but rarely. Gessner, on the other hand, was inclined to discount the effect of the change in diet, and to attribute the change to increased physical labor and to the loss of body fat.

Whatever the true explanation may be, this experience seems to indicate that hard physical labor and an approach to a vegetable diet can play a definite part in the prophylaxis of eclampsia, and raises the question as to why milk, the other great prophylactic, should have a similar effect. At first glance, this appears improbable, as milk contains large amounts of animal protein and fat, so that the only point in common between such a diet and the German war diet is the presence of a high inorganic salt content.

Whether an abundant supply of inorganic material has any prophylactic effect, or whether an actual or relative mineral deficiency is associated with the causation of eclampsia can only be decided in the future, but it is interesting to consider that one of the by-effects of the war has been to direct our attention to the mineral metabolism.

XII. *Physicochemical Changes.*—For some time Zangemeister has believed that edema of the brain is the essential cause of eclampsia, and has thus resuscitated the Traube-Rosenstein theory which was so popular sixty years ago. In 1919, he advanced his hydrops gravidarum theory, according to which, under the influence of some substance connected with pregnancy, the permeability of the capillary walls becomes increased, with the result that fluid escapes into the tissues, giving rise to edema and anasarca. To overcome the increased peripheral resistance the blood pressure is raised, albuminuria results from the edema of the secreting renal cells, and the headache and eye signs from swelling of the brain and retina, or, as he tersely expressed it in 1921, "the long sought for cause is indirectly water." In view of Plass' results indicating a tissue retention of various crystalloid metabolic products, it seems probable that the water which escapes into the tissues must carry with it certain other constituents of the plasma.

There are, however, two serious objections to Zangemeister's theory: first, that it does not explain the production of the characteristic hepatic lesions, and second, that it takes no account of the cases of eclampsia without edema, which in my experience offer the most serious prognosis.

Zangemeister's theory is supported to some extent by the observations made by means of the capillary microscope, whose clinical use was introduced by Weiss, in 1916, and extended into obstetrics particularly by Hinselmann. In this way it is possible to observe the circulation through the capillaries at the base of the finger nails, and to note peculiarities in its behavior. Hinselmann in various articles has pointed out that in toxemia and eclampsia spasmodic contractions of the capillaries are constantly recurring, which result in periods of complete cessation of the current and occasionally in actual reversal of direction. While such changes are probably secondary in character, they are very suggestive.

It was thought for a time that Hüssy had discovered a plausible explanation for such variations, as he claimed to have found in eclamptic blood a vasoconstrictor substance, but Paul was unable to confirm his observations.

Macht and Losee have demonstrated by phytopharmacological study that the blood serum of eclamptic women is no more toxic to the seedlings of *lupinus albus* than that of normal nonpregnant or pregnant individuals, and they therefore conclude that there is no evidence that eclampsia is associated with the presence of a substance which is toxic to vegetable tissue. At the same time, they admit that their investigations by no means disprove the toxemic nature of the disease, but merely indicate that one type of "toxin" is not involved.

In summing up this section, it is evident that the cause of eclampsia has not been discovered, and that the peace of mind of all concerned would have been increased, had many of the so-called contributors never written, or at least had withheld their contributions sufficiently long to subject them to ordinary self-criticism.

Diagnosis.—Except for the possibility of confusion with purely uremic conditions, the recognition of eclampsia usually offers no difficulty. It might be confounded with acute poisoning from strychnine, phosphorus, or nitrobenzol, as in a case reported by Schild. However, such instances are extremely rare, and careful inquiry into the history of the patient should prevent error. Generally speaking, one is much more likely to make a diagnosis of eclampsia too frequently than to overlook the disease, as epilepsy, acute yellow atrophy of the liver, and even hysteria may simulate it. Consequently such conditions should be borne in mind whenever convulsions or coma appear during pregnancy, labor, or the puerperium, and must be excluded before a positive diagnosis is made. Convulsions occurring later than the third day of the puerperium are rarely a manifestation of postpartum eclampsia, and such a diagnosis is permissible only when characteristic changes in the blood pressure and urine are demonstrable. Very occasionally an accurate clinical diagnosis cannot be made, and the nature of the attack must remain in doubt unless the patient comes to autopsy.

Prognosis.—The prognosis is always serious, eclampsia being one of the most dangerous conditions with which the obstetrician has to deal. Dublin, in 1918, and Woodbury, in 1926, having pointed out that it, together with the other toxemias of pregnancy, was responsible for 26.4 and 26.8 per cent, respectively, of the total mortality from childbirth in this country. The average mortality varies from 20 to 25 per cent, while that of the child approaches 50 per cent. In 2,005 cases of eclampsia occurring in Great Britain and analyzed by Eden, the mortality was 22.5 per cent, ranging from 10.3 per cent in Dublin to 25.1 per cent in the North of England.

Naturally the prognosis will depend upon the type of patient, being much more favorable when she is seen immediately after the first convulsion than in neglected cases which are sent to the hospital only as the last resort. Furthermore, the prognosis will vary according as the disease is mild or severe in type. We owe this distinction to Eden, who designates as severe any case of eclampsia in which two or more of the following symptoms are present: (1) prolonged coma; (2) pulse rate above 120; (3) temperature 103° F. or higher; (4) blood pressure above 200 millimeters; (5) more than 10 fits; (6) 10 grams or more of albumin in the urine; and (7) the absence of edema. In 706 of his cases, which could be so classified, the mortality was 6.6 and 37.2 per cent in the two groups respectively, as contrasted with 5.6 and 29.3 per cent in 275 cases treated in our clinic up to April, 1926. Finally, as will be indicated in the following section, the prognosis will depend upon the treatment pursued, and generally speaking will be far better when it is conservative.

Formerly the prognosis was thought to be more gloomy in ante- and intrapartum eclampsia than in the postpartum variety, but with the adoption of more conservative methods of treatment the death rate in the former has become materially diminished, while it has remained stationary in the latter. Thus, in 165 cases occurring in our service during the twelve years ending April, 1926, the mortality was 13.2 and 13.9 per cent in the two groups, respectively, and the entire mortality in the postpartum group occurred in the "severe" cases.

There is considerable discrepancy of opinion concerning the relative prognosis in primiparous and multiparous women. Thus, Goldberg and Lichenstein state that the disorder is twice as dangerous in the latter. Olshausen, on the other hand, believes that there is no difference in the two groups, and his contention is borne out by Eden's figures, which show a mortality of 22.9 and 27.4 per cent, respectively. In all probability the prognosis really depends much more upon the severity of the attack than upon the number of children that the woman has borne.

In individual cases it is often difficult to predict the course of the disease, some patients dying in the first seizure, while others recover after a great number, Jardine reporting a recovery after 200 convulsions. Seitz states that the prognosis becomes worse with each convulsion up to 20 or 30, but that a greater number does not necessarily add to the gravity of the case, the prognosis depending upon the rapidity with which they follow one another and the duration of the coma after each attack.

Valuable prognostic data are also afforded by the condition of the pulse and temperature. When the former is of fair quality between the attacks the outlook is usually good; whereas a weak, rapid, and thready pulse usually indicates a fatal issue, particularly if the temperature is high. The persistence of a high arterial pressure is always of bad prognostic significance, especially if the diastolic is elevated out of proportion to the systolic reading. Complete anuria, jaundice, and the inability to sweat are ominous symptoms. Apoplexy, paralysis, and edema of the lungs are serious complications and usually end in death.

If the eclampsia comes on during pregnancy the prognosis is favorably affected by the death of the fœtus, the convulsions usually ceasing soon afterward. The presence of marked edema in general justifies a more favorable prognosis than when there is no demonstrable swelling, which suggests that the retention of fluid in the tissues should be regarded as a protective mechanism, and possibly serves to withdraw temporarily from the circulating blood certain substances which may do harm.

Formerly, I held that it was unusual for eclampsia to recur in subsequent pregnancies, and that women who recover from an attack develop relative immunity. Unfortunately, more extended experience has shown that I was in error. Hinselmann states that recurrence was recorded in 1.92 per cent of the cases which he collected, and Peckham noted it in 4 per cent of a series of cases from this clinic. Moreover, the danger does not end there, as Peckham found that chronic nephritis had developed in 17 out of a series of 74 patients (23 per cent), who were restudied one or more years after the attack. In view of the rapidity with which most patients appear to recover, this finding was surprising, more particularly as the complication had developed in a number of patients, who appeared to have recovered completely by the end of the puerperium. Upon analyzing the details of the eclamptic attacks, Peckham found that chronic nephritis is much more likely to develop after severe than after mild eclampsia, particularly when it is of the antepartum type. Furthermore, its development appears to be favored by the following factors: age over thirty years, multiparity, blood pressure above 200 millimeters, albuminuria exceeding 10 grams per liter, but it does not seem to be influenced by the number of convulsions, nor by the duration of coma. Such findings are of great importance and serve to emphasize the importance of making every effort to prevent the outbreak of eclampsia, as well as the obligation to keep under observation for months those who are unfortunate enough to develop it.

The fœtal mortality must always be high since the disease frequently appears while the child is still premature, when its chances of living would be only moderate even were the mother not suffering from a serious disease. Moreover, except in the postpartum variety, the therapeutic measures adopted in the interests of the mother still further prejudice its chances. For these reasons, a fœtal death rate of approximately 50 per cent is not surprising, and in our hands but little more than one-third of the children left the hospital with their mothers.

Treatment.—(*a*) *Prophylactic.*—As, in the vast majority of cases, eclampsia is preceded by premonitory symptoms, its prophylaxis is in many ways more important than its actual cure, and is identical with that recommended for pre-eclampsia. Indeed, the chief aim in treating the latter condition is to prevent the possible outbreak of eclampsia. Hence the necessity of regular and frequent examinations of the urine, blood pressure determinations, and weighings, and the immediate institution of appropriate dietary and medical treatment as soon as symptoms appear, which indicate that the eliminative processes are at fault. By the employment of these precautionary measures, and by promptly terminating pregnancy in those cases which do not improve, or which become progressively worse under treatment, the frequency of eclampsia will be greatly diminished and many valuable lives saved. On the other hand, we have become convinced that prophylactic treatment, while productive of untold good, is not invariably successful; and that those who teach that eclampsia is always preventable, and that its occurrence indicates neglect on the part of the obstetrician, take too extreme a view and have been led astray by their enthusiasm.

(*b*) *Curative.*—As has already been indicated, the curative treatment of eclampsia must remain empirical and unsatisfactory until its actual cause has been discovered. Consequently, although no unanimity exists among authorities as to the best course to pursue, it may be said that two diametrically different methods of treatment are advocated—radical and conservative. The proponents of the former insist that the essential feature is to empty the uterus by operative means as soon after the first convulsion as possible, while the advocates of the latter claim that this is not only unnecessary, but is actually harmful.

For many years, in accordance with the views then prevailing, it was my practice to empty the uterus as soon as possible after the occurrence of the first convulsion, but the results were so unsatisfactory that I gradually became more and more conservative, and since 1923 I have employed a modification of the treatment recommended by Stroganoff, which has led to a definite diminution in mortality. Consequently, I shall outline the treatment now practiced in our clinic, and afterwards I shall refer to methods in vogue elsewhere.

In the first place the patient should be in a hospital, if possible, as the facilities afforded by a well-regulated service are greatly superior to those available in the most comfortable home. Competent nurses must be in constant attendance until all acute danger has passed. The patient should be in a darkened room and every effort made to secure the greatest possible quiet. If comatose, she should be placed on one side, with the foot of the bed elevated, so that mucus collecting in the pharynx can escape. If necessary, it should be removed by means of swabs. A thick rubber tube, or a wooden tongue depressor thickly covered with gauze, should be placed between the jaws, in order to avoid injury to the tongue during a convulsion.

Immediately upon admission, ¼ grain of morphia is given hypodermically, and following it the patient is catheterized and examined medically and obstetrically. If laboratory facilities are available, 200 cubic centimeters of blood should be withdrawn for chemical investigation, under nitrous oxide anesthesia if necessary. At this time there should be no thought of delivery unless the cervix is fully dilated.

One hour after admission, 2 grams of chloral in 100 cubic centimeters of milk are administered by mouth if the patient is conscious, otherwise per rectum. Two hours later the morphia is repeated, and seven hours after admission the chloral. The same dose of chloral is again repeated thirteen and twenty-one hours after admission, but no further morphia is given during the first twenty-four hours. If the patient is conscious, she should drink water freely, but if she is unconscious nothing should be given by mouth. Too much stress cannot be laid upon this advice, as aspiration pneumonia, which is so common a cause of death later in the puerperium, is frequently due to injudicious attempts to force fluid or nutriment upon the unconscious patient. However, if the coma lasts for more than twelve hours the propriety of the intravenous administration of 500 cubic centimeters of 5 per cent glucose solution should be considered.

If the attack is mild or moderately severe, and the patient is not in labor, the convulsions usually soon cease, but the patient remains in a semitorpid condition, becoming brighter and more alert as her condition improves. Frequently, the improvement is progressive, no further convulsions occur, the blood pressure falls and the albuminuria diminishes. In other words, the eclampsia becomes intercurrent, and labor sets in some days or weeks later, without recurrence of the condition and is followed by the birth of a live or dead child as the case may be. In the majority of cases, unfortunately, the improvement is only temporary, and after a few days the blood pressure begins to rise, the albumin to increase and the general condition to become less satisfactory. In such circumstances, labor should be induced by the introduction without anesthesia of the largest size bougie possible, which is usually followed by the spontaneous extrusion of the child without any recurrence of convulsions. On the other hand, if the patient is admitted in labor, or if pains supervene during the course of the attack, labor may go on without serious disturbance, so that one is occasionally surprised by the rapidity with which the first stage is completed. As soon as the cervix has become completely dilated, delivery should be effected by forceps under gas anesthesia.

Unfortunately, in the more severe cases, irrespective of whether the patient is in labor or not, the course of events is not always so satisfactory, and in spite of the treatment the convulsions become more frequent, the coma deepens and the general condition becomes more alarming. In such circumstances, and particularly if the cervix shows no sign of dilatation, cesarean section under local or spinal anesthesia may occasionally be the procedure of choice, although we have employed it in only a few instances. Such interference, however, should be regarded as exceptional and should be considered only as a last resort. The operation should never be done under general anesthesia, as the work of Stander has shown that it tends to exaggerate the chemical changes in the blood brought about by eclampsia, in addition to its well recognized tendency to provoke degenerative changes in the already damaged liver.

In severe cases, if laboratory facilities are available, the carbon dioxide combining power of the blood should be determined at suitable intervals and if it is found to be so lowered as to indicate the existence of a severe acidosis, that condition should be combated by the intravenous administration of 30 units of insulin, together with a protective dose of 60 grams of glucose in 10 per cent solution. In general, it may be said that the indiscriminate treatment of acidosis probably does more harm than good, so that I advise against it unless the condition of the patient can be controlled by accurate chemical observation. It will be noticed that nothing has been said concerning venesection, as the 200 cubic centimeters of blood withdrawn for chemical study is too small an amount to be of any therapeutic significance; nor has any mention been made of the use of catharsis or sweating. In my experience the last two are of little value, while the value of venesection will be considered later.

The table on page 674 shows that our results have been nearly twice as good following conservative treatment, and that in 129 cases of ante- and intrapartum eclampsia treated between 1912 and 1926, the mortality was 1.9 per cent in the mild and 21.3 per cent in the severe cases. In other words, conservative treatment gave very satisfactory results in the former, but left a great deal to be desired in the latter.

It might be added that our results to date have remained essentially the same, so that we believe that the treatment in vogue has been the means of saving many lives which would have been lost under radical treatment. Furthermore, stress should be laid upon the fact that one of the great advantages of the former is that it affords a possibility for the disease to become intercurrent, so that, if the improvement is not continuous, labor can be induced by means

RESULTS IN 275 CASES OF ECLAMPSIA
(110 up to Dec. 31, 1911; 165 from 1912 to March 31, 1926)

	SERIES 1 (Radical)		SERIES 2 (Conservative)		PER CENT OF DEATHS	
	Cases	Deaths	Cases	Deaths	Series 1	Series 2
Antepartum:						
Mild	33	5	30	0	15.1	0.0
Severe	28	10	54	11	35.7	20.4
Intrapartum:						
Mild	16	2	24	1	12.5	4.17
Severe	8	4	21	5	50.0	23.8
Postpartum:						
Mild	15	0	24	0	0.0	0.0
Severe	10	4	12	5	40.0	41.6
TOTAL	110	25	165	22	22.8	13.3

of the bougie in the only slightly sick patient, instead of by performing a radical operation upon a seriously ill patient.

For years, Stroganoff has claimed that he has obtained surprising results by his so-called prophylactic method, and in 1928 reported a gross and corrected mortality of 2.6 and 0.3 per cent respectively in the last 300 cases of eclampsia treated. I am unable to offer a satisfactory explanation for the difference between his results and ours, but I am inclined to believe that it must be due to a difference in the type of case treated. As far as I can gather from his writings most of his cases arise in women awaiting delivery in his clinic, with the result that treatment is usually instituted immediately after the onset of the first convulsion, whereas the major part of our material consists of women who have been treated at home by their physicians and only sent to the clinic after their condition has become desperate.

Of one thing concerning the treatment of eclampsia I am convinced, and that is that the worst possible treatment consists in the routine employment of cesarean section under general anesthesia. Eden stated in his analysis that the results following it were as bad as after accouchement forcé, while the tabulations of Peterson and Eardley Holland showed a mortality of 25.8 and 32 per cent, respectively. Later figures only serve to sustain these conclusions. Thus, in 47 cesareans for eclampsia in New Orleans, between 1921 and 1926, the mortality was 41.5 per cent, while the figures of Gordon of Brooklyn and of Miller of Hartford show a mortality of 26 and 19.3 per cent in 104 and 31 cases, respectively.

In this connection, it should be remembered that the operations in Gordon's series were performed during the five years ending with 1926, so that it is impossible to ascribe the excessive mortality to defective operative technic. Indeed, the only satisfactory results following cesarean section with which I am acquainted are those of Stoeckel—119 operations with a mortality of 8.4 per cent.

As he operated as soon as possible after the first convulsion, it is evident that he performed many operations unnecessarily, in that he did them in the mild cases in which they were not required, as well as in the severe ones in which such radical interference might be of value.

Venesection has been employed in the treatment of eclampsia from time immemorial, and we are indebted to Lichtenstein for placing it upon an intelligent basis. In the Leipzig clinic he came to depend more and more upon its use, with the result that the mortality fell from 16.7 to 9.4 per cent in the decades ending in 1911 and 1921, respectively. He advocated withdrawing 1000 cubic centimeters of blood and restricting obstetrical interference to forceps or version after the cervix had become fully dilated. As a result he noted that in many antepartum cases the eclampsia became intercurrent, and it is to him that we owe that term. In the period of transition from radical to conservative methods, I made frequent use of venesection, and found that it was associated with a considerable diminution in mortality, but whether *post hoc* or *propter hoc,* I am unable to state. The latest development along these lines we owe to Irving and Taylor, who have applied Abel's plasmaphæresis to the treatment of eclampsia and severe toxemias. They withdraw the blood, and after removing the plasma by centrifugalization, add normal saline to the corpuscles and reintroduce them into the circulation of the patient. This, of course, is a rational method of removing any "toxins" from the blood, but it is too soon to say how valuable the procedure will prove, more particularly as they have employed it in only four cases.

On the other hand, Fitzgibbon and Solomons report a mortality of 10.3 per cent—the lowest in the British Isles—with the so-called Dublin treatment. This consists in starvation, gastric and colonic lavage and the submammary infusion of sodium bicarbonate solution. Epsom salts are given after the gastric lavage and large quantities of sodium bicarbonate are used for flushing the bowels. Morphia, chloral, chloroform and venesection are not employed, and delivery is effected only after the cervix has become completely dilated. Solomons, in 1928, informed me that he makes free use of morphia, while retaining the other features of the Dublin method.

During the past few years, various American writers, such as Lazard, Dorsett, Dieckmann and others, have reported good results following the intravenous injection of 20 cubic centimeters of a 10 per cent solution of magnesium sulphate every hour until the convulsions cease. They use no other medication and make no attempt at delivery until the cervix has become fully dilated. Lazard and his associates report 103 cases so treated with a gross mortality of 13.5 per cent—a figure about identical with our own, and state that in 14 out of 50 cases of antepartum eclampsia, the condition became intercurrent. In view of the fact that several writers give much larger doses of magnesium sulphate than Lazard and his associates, Stander investigated the subject experimentally and came to the conclusion that 6 grams of the drug could be administered safely within 24 hours provided not more than 20 cubic centimeters of a 10 per cent solution are administered at a single dose.

In 1926, Miller and Martinez, stimulated by the work of Major, began the intramuscular injection of liver extract or heparmone in the treatment of eclampsia and the toxemias in general, and in 1929 reported that they had treated 43 cases of eclampsia with a mortality of 6.9 per cent. They injected 10 cubic centimeters of heparmone at intervals of 10 to 60 minutes until the blood pressure fell or the convulsions ceased, and made no attempt at delivery until the cervix was fully dilated. Naturally, the number of cases is too small to establish the value of heparmone, but Mendenhall and Smith believe that it is not only valueless, but is distinctively dangerous. Nevertheless, the experiment is of interest, as it tends to show that eclampsia so treated does as well as with the various methods already enumerated.

To recapitulate, it appears that essentially as good results are obtained by the use of sedatives, venesection, eliminative treatment (Dublin method), magnesium sulphate, or liver extract, provided no attempt at delivery is made until the cervix has become completely dilated; whereas the worst results follow cesarean section under general anesthesia and the various types of accouchement forcé. In other words, it appears that the results following all types of conservative treatment are much better than those following radical treatment. Accordingly, it would seem that in the past large numbers of women had been sacrificed in the attempt to terminate the pregnancy promptly, and that many lives could have been saved had more conservative treatment been employed. Furthermore, it appears that in mild cases treated conservatively the mortality is almost negligible, while in severe cases it remains high whatever may be done, but that it is still further increased when labor is terminated by radical procedures under general anesthesia. Unfortunately, we as yet are unable to predict after the first fit or so whether the individual case will prove to be mild or severe, and consequently one of the first desiderata toward effecting improvement in our results is to establish means of such differentiation, when the mild cases would be expected to recover if not treated too energetically. Furthermore, it should be regarded as axiomatic that great improvement cannot be expected in the severe cases, until the true etiology of the disease has been discovered, and a basis established for its causal treatment. In the meantime, it should be remembered that conservative gives better results than radical treatment, and when we are tempted to interfere radically in seriously ill patients we should constantly bear in mind the time-honored motto—*"primum non nocere."*

In conclusion, a few words will be said concerning several procedures whose use has been abandoned or whose value has not been established.

Thyroid extract has been advocated by Nicholson, who advises that 70 to 80 grains be given daily during the attacks. It was used by Sturmer in a series of 41 cases with 5 deaths. Since other therapeutic measures were employed as well, it is impossible to judge of its efficiency. In the few instances in which it was used in my clinic favorable results were not obtained.

The use of veratrum viride, which is highly praised by many American writers, has never appealed to me, and Sturmer's statistics from the East India

Medical Service, where it was used for twenty years, show a maternal mortality of 45 per cent. After reading the enthusiastic report of Mangiagaili, and of Craigin and Hull concerning its merits, I felt that I was perhaps wrong in rejecting it. Accordingly, in a series of cases I gave it to every other patient, while the alternate patient was treated in identically the same manner except for the veratrum. While the hypodermic administration of 5 to 10 minims of the fluid-extract, repeated if necessary, undoubtedly leads to a marked slowing of the pulse, and occasionally to an almost alarming fall in blood pressure, the patients did neither better nor worse than those who did not receive it. For this reason I abandoned its use.

The intravenous injection of serum from normal pregnant women has been recommended with the idea that it may furnish some antibody, which should be normally present, and thus neutralize the supposititious eclamptic toxin. With somewhat the same idea, Blair Bell has recommended the transfusion of blood from normal individuals, but proof of the efficiency of either suggestion has not yet been adduced.

In 1904, Krönig employed lumbar puncture in eclampsia with beneficial results. He found the cerebrospinal fluid under a considerably increased tension, and noted apparent improvement following the withdrawal of from 20 to 10 cubic centimeters. The procedure has been rather extensively employed, and Spillman, after recently reviewing the literature upon the subject, found that the mortality was 62 per cent, which cannot be regarded as a hearty recommendation. From what I have seen, it appears to be unnecessary in mild, and useless in severe cases. Wieloch, in 1925, under the influence of Zangemeister, went a step further and advocates suboccipital trephining for the purpose of lowering blood pressure and stimulating diuresis, and believes that it serves a useful purpose.

Renal decapsulation was performed in a case of eclampsia by Edebohls, in 1902, although it had previously been suggested by Sippel. The former considered that it acted by relieving the intrarenal tension, and thereby favored the resumption of urinary section. The subject has been reviewed by Sippel, Brindeau and others, who believe that it is of value in cases of total suppression following delivery, and may be employed as a last resort

In view of the marked liability of eclamptic women to infection, all operative procedures must be conducted in the most rigidly aseptic manner, particular care being taken to avoid the contamination of the vagina and the hands of the operator by fecal material.

UNCLASSIFIED TOXEMIAS

Under this heading are grouped together a number of presumably toxemic conditions, which cannot be classified in any of the groups thus far considered. In the tabulation of the last 800 cases of toxemia studied in our clinic, Stander found 7.5 per cent, which differed in one or more particulars from the descriptions given above, and which therefore could not be placed in any definite category at the time of discharge from the clinic. As far as possible, all such patients are readmitted to the service for renewed study six or eight weeks after delivery, when in many instances the nature of the condition can be established. In other cases, however, that is not possible, and the patient disappears with a definite diagnosis not made. I consider it important to mention such cases, as they afford further proof, if one is needed, of our ignorance of the fundamental basis of the toxemias of pregnancy, as well as of the artificiality of our methods of classification.

In times past, when chloroform was routinely employed as an anesthetic, an occasional patient who had been apparently well during pregnancy developed a toxemic condition during the first few days of the puerperium, often accompanied by slight jaundice. Most such patients recovered, but a few died, and we have since learned to recognize that their symptoms were a manifestation of late chloroform poisoning, and not of a toxemia.

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CHAPTER XXVII

COMPLICATIONS DUE TO DISEASES AND ABNORMALITIES OF THE GENERATIVE TRACT

DISEASES OF THE VULVA AND VAGINA

Varices.—Varicose veins sometimes appear in the lower part of the vagina but are more common around the vulva, where they may attain considerable proportions and give rise to a sensation of weight and discomfort. Treatment has practically no effect upon the local condition. In rare instances the varices may rupture during pregnancy, though this accident is more frequently observed at the time of labor, when profuse and sometimes fatal hemorrhage may result if appropriate surgical treatment is not available.

Inflammation of Bartholin's Glands.—Pyogenic micro-organisms may gain access to Bartholin's glands and give rise to abscess formation. In this event the labium majus on the side affected becomes swollen and painful, and incloses a collection of pus. Most often the infection is gonorrheal in origin, though other bacteria are sometimes associated with the gonococcus. Aside from the pain and discomfort, this complication may be the starting-point of a puerperal infection. For these reasons, whenever a labial abscess develops during pregnancy it should be opened and drained; or, better still, in the first 7 months of pregnancy the entire pus sac should be excised. Owing to the increased vascularity incident to the inflammatory process, as well as pregnancy, enucleation is sometimes accompanied by considerable loss of blood, and is not always easy.

Condylomata.—As the result of gonorrheal or other irritation, condylomata sometimes develop on the vulva or about the vaginal opening. If small, they have no effect upon the course of labor, except that the purulent secretion by which they are bathed increases the chances of puerperal infection. If detected some time before the expected date of confinement they should be removed by the application of trichloracetic acid. Occasionally, however, they attain immense proportions, as shown in Figure 493, and may cause serious dystocia. If the patient is seen several months prior to the end of pregnancy they should be removed by excision and fulguration; whereas, if not seen until the time of labor, cesarean section may be indicated—first to avoid hemorrhage incident to injury to the obstructing condyloma, and secondly to decrease the possibility of infection.

Relaxation of the Vaginal Outlet.—Even in nulliparous women the congestion incident to pregnancy frequently causes the anterior or posterior vaginal wall to protrude through the vulva as a redundant mass; while in multiparous women, particularly when the outlet is torn or relaxed, a distinct cystocele or rectocele may result. This condition is generally associated with dragging pains in the back and lower abdomen, and may interfere with locomotion. It is not amenable to treatment during pregnancy, though the symptoms may be temporarily relieved by rest in bed.

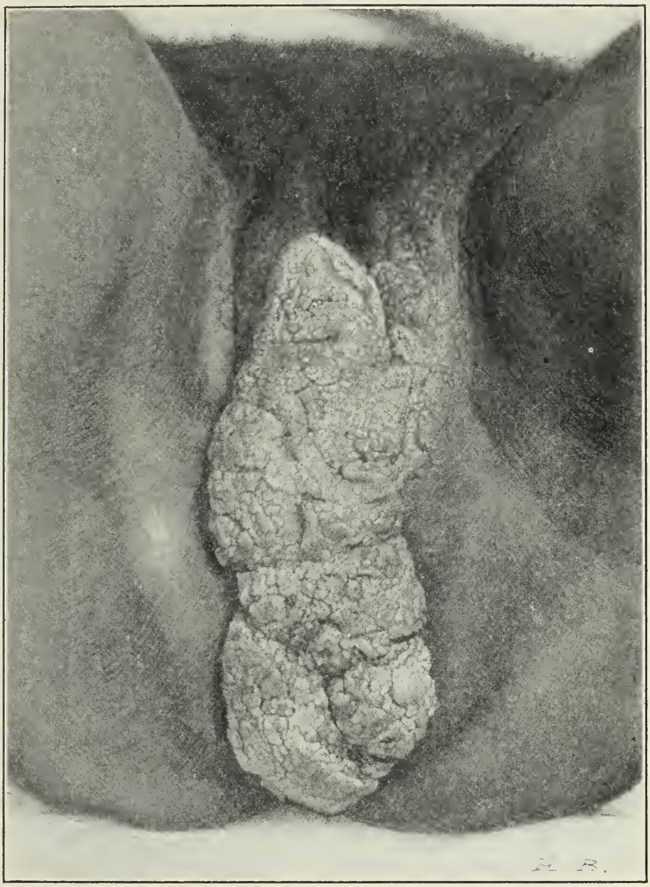

Fig. 493.—Condylomata of Vulva, Treated by Fulguration and Excision During Pregnancy, Normal Labor.

Vaginitis.—This complication has already been considered in Chapter XXV, under the heading of Gonorrhea.

Colpohyperplasia Cystica.—This rare condition, first described by Winckel, is characterized by the presence in the vaginal mucosa of numerous small cavities filled with clear fluid or gas and forming elevations upon its surface. Although not amenable to treatment during pregnancy, it usually disappears soon after childbirth. The researches of Lindenthal render it probable that the lesion is sometimes due to infection with Bacillus aërogenes capsulatus, and Jaeger has been able to produce it experimentally in animals.

DISEASES OF THE CERVIX

Cervical Endometritis.—Gonorrheal infection of the cervical canal is frequently observed during pregnancy, the most prominent symptom being a profuse and persistent leukorrhea. The treatment has already been considered.

Carcinoma.—About once in 2000 cases, according to Sarwey, but less frequently in this country, pregnancy is complicated by carcinoma of the cervix. It is most common in women between the thirtieth and fortieth years of life, about two-thirds of the cases collected by Sarwey having occurred within this decade, while the youngest patient was twenty-six years old.

In the majority of instances the condition has existed before conception, but it may make its appearance during pregnancy. A bloody, foul-smelling vaginal discharge is suggestive of malignant disease, but unfortunately the early stages are often unaccompanied by symptoms, and may escape detection unless a vaginal examination is made for some other reason, when an indurated and excavated ulceration of the cervix is discovered.

Pregnancy tends to bring about rapid growth and extension of a preëxisting carcinoma. On the other hand, the malignant disease influences pregnancy very unfavorably, abortion being noted in 30 to 40 per cent of the cases. Furthermore, if the patient reaches full term the dangers of labor are greatly increased. In the first place, the presence of the ulcerating crater affords opportunity for the access of pyogenic bacteria to the uterine cavity; while the cervix may be so indurated by carcinomatous infiltration that dilatation becomes impossible and spontaneous rupture of the lower uterine segment becomes imminent, unless suitable operative measures are undertaken to prevent it. In other instances, the cervix may be lacerated and give rise to profuse hemorrhage. In 603 cases collected by Sarwey (1899), the mortality at the time of labor, or during the puerperium was 43.3 per cent, 8 per cent of the patients dying undelivered.

The treatment of pregnancy complicated by carcinoma of the cervix differs according to the period at which the diagnosis is made and the extent to which the disease has progressed. If the condition has not extended beyond the cervix, immediate abdominal hysterectomy should be performed in the hope of effecting a permanent cure, without regard for the chances of the fœtus. On the other hand, if the case is inoperable, gestation should be allowed to continue in the interests of the child, and cesarean section performed at term, if the condition of the cervix is such as to render spontaneous delivery improbable. According to Weibel, the results following radical operations are unexpectedly good, as he was able to report that two-thirds of the patients operated upon in the Wertheim clinic had no recurrence five or more years later.

The treatment of inoperable cases by means of radium raises another question. If it is thought advisable to employ it, the uterus must be emptied as a preliminary procedure, since the action of the radium will inevitably lead to the death of the child. In such circumstances cesarean section may be indicated, even though the child is not viable.

DEVELOPMENTAL ABNORMALITIES OF THE UTERUS

Abnormalities in the development or fusion of one or both müllerian ducts may result in malformations, which sometimes possess an obstetrical significance. Various degrees of malformation—from an almost total absence of the uterus on the one hand to its duplication on the other (uterus didelphys)—are encountered. The accompanying diagrams (Figs. 494 to 500) give an idea of the nature of the more important varieties.

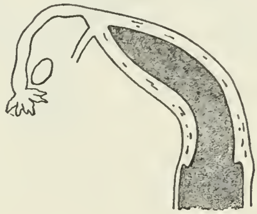

FIG. 494.—DIAGRAM OF UTERUS UNICORNIS (Kehrer).

Pregnancy may be associated with any one of these malformations provided an ovum be cast off from the ovaries and no serious obstacle be opposed to the upward passage of the spermatozoa and their subsequent union with it.

Pregnancy in the Rudimentary Horn of a Double Uterus.—In this condition the course of pregnancy is exposed to serious modifications. We owe to Mauriceau the first description of a case of this character, but since his time many examples have been reported.

In 78 per cent of the 84 cases collected from the literature by Kehrer, in 1900, the proximal end of the rudimentary horn did not communicate with the uterine cavity, so that in them pregnancy must have followed external migration of the spermatozoa or of the fertilized ovum.

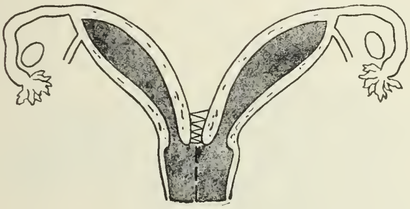

FIG. 495.—UTERUS PSEUDODIDELPHYS (Kehrer).

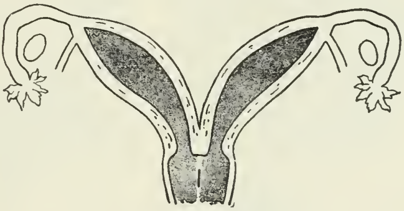

FIG. 496.—UTERUS BICORNIS DUPLEX (Kehrer).

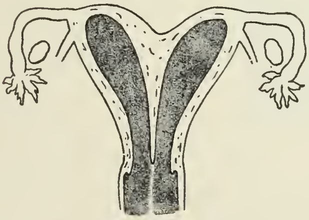

FIG. 497.—UTERUS BICORNIS SEPTUS (Kehrer).

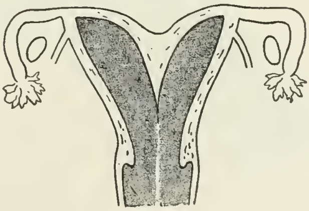

FIG. 498.—UTERUS BICORNIS SUBSEPTUS (Kehrer).

The development of pregnancy in a rudimentary horn is associated with the formation of a decidua in the nonpregnant horn, as well as by a marked increase in its size. Unless there is free communication between the two horns, which is but rarely the case, a pregnancy in this situation is a very serious occurrence, since normal delivery is impossible. If the muscular tissue of the rudimentary horn is poorly developed, as is usually the case, spontaneous rupture occurs within the first four months and may lead to the death of the patient from intraperitoneal hemorrhage. This result was noted in 87, 47.6, and 5.5 per cent of the cases collected by Sänger, Kehrer, and Beckmann, respectively, in 1884, 1900, and 1911. The marked improvement is attributable to greater accuracy in diagnosis and more frequent recourse to operative interference. On the other hand, if the muscular tissue is abundant, the pregnant horn may hypertrophy normally, and the pregnancy go on to term. In such cases, the fœtus, if not removed by operative means, may be gradually eliminated by suppurative processes, or be converted into a lithopedion.

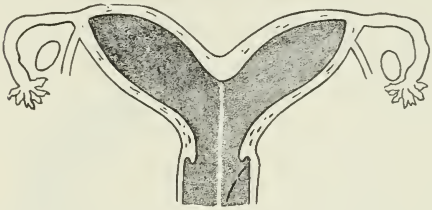

Fig. 499.—Uterus Bicornis Unicollis (Kehrer).

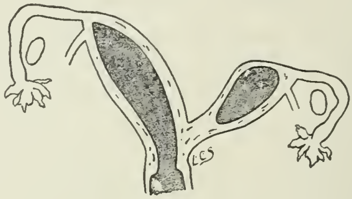

Fig. 500.—Uterus Bicornis Unicollis with Rudimentary Horn (Kehrer).

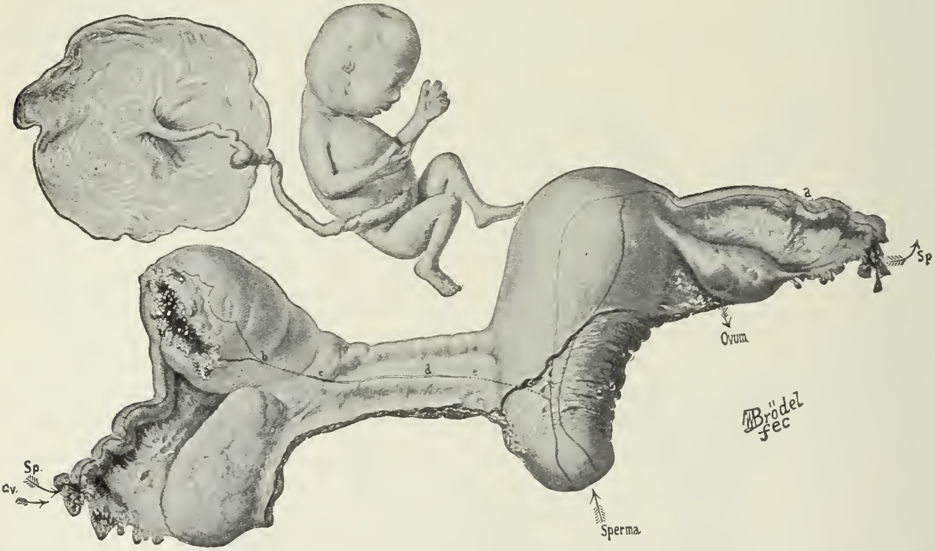

Fig. 501.—Pregnancy in a Rudimentary Left Uterine Horn. External Migration of Ovum (Kelly).

The existence of pregnancy in a rudimentary horn can occasionally be recognized during the early months, a positive diagnosis having been made in 20 per cent of Kehrer's cases. When a tumor corresponding in size to the duration of pregnancy can be detected alongside of what appears to be the slightly enlarged uterus, this condition should always be thought of. In differentiating it from a tubal pregnancy, it is important to remember that the round ligament is felt coming off from the distal side of the tumor instead of from its proximal or uterine portion, as in the latter condition. In the later months, a diagnosis is usually not made until false labor sets in at term. In other cases this does not occur and the child dies; but, in either event, no abnormality is suspected until one attempts to empty the uterus, when it is found that its cavity is empty and that the child lies in a sac to one side of it, which must represent either a pregnant tube or a rudimentary horn. A satisfactory differentiation can always be made by determining the location of the round ligament as described above.

Treatment.—If the condition be diagnosticated, treatment consists in promptly opening the abdomen and amputating the pregnant horn. This operation was first performed by Sänger, in 1884, and has since been repeated on many occasions with constantly improving results, Kehrer and Wells having reported 44 cases up to 1900, and Beckmann a large series in 1911, with a mortality of 13.4 and 4.3 per cent, respectively. Too frequently, however, the first suggestion of the existence of the abnormality is afforded by the symptoms of intraperitoneal hemorrhage, when the operation is undertaken in the expectation of finding a ruptured extra-uterine pregnancy.

Pregnancy in Uterus Unicornis.—Occasionally only one horn of the uterus is developed, the opposite tube and ovary being lacking or arising from the lower portion of the uterus. In such cases pregnancy usually pursues an uneventful course, and the abnormality is only accidentally recognized at the operating or autopsy table.

Pregnancy in Uterus Bicornis.—When the two horns of the uterus are well developed, but no connection exists between them, as in uterus didelphys, or when they are partly fused, as in the various varieties of uterus bicornis, pregnancy may occur in either horn. In the very rare instances in which a twin pregnancy is observed, the two products of conception may occupy the same horn, although now and again a fœtus may be found in each, as in several of my cases.

When pregnancy occurs in one horn of a bicornuate uterus, the other undergoes sympathetic hypertrophy and a distinct decidua is formed in its cavity. Ordinarily there is no interference with the course of pregnancy, and spontaneous labor may be looked for. Much more rarely the nonpregnant horn may block the pelvic cavity, and give rise to dystocia similar to that produced by tumors of other origin. In a case observed in my clinic and reported by Bettman, the nonpregnant horn obstructed the pelvic cavity and gave rise to rupture of the uterus. Van der Velde made a critical study of the subject in 1915, and has collected from the literature a series of cases requiring cesarean section or some other radical intervention.

Miller, in 1922, analyzed the clinical histories of 54 cases reported in the literature. That the abnormality does not interfere with the possibility of conception is shown by the fact that 31 of the 34 married women conceived and had 67 pregnancies. It does, however, predispose toward the occurrence of abortion and premature labor, as only 61 per cent of the pregnancies went to term. When difficulty was encountered at the time of labor, it was usually due to mechanical interference by the enlarged nonpregnant horn.

The diagnosis is usually not made, as the uneventful course of pregnancy affords no indication for careful exploration, and in most patients spontaneous labor occurs at term; although Halban states that a pathognomonic sign is afforded by the palpation of the vesicorectal ligament, as a band extending upward from the bladder over the top of the uterus, and lying between the two round ligaments. In our case, which was reported by Bettman, the patient had given birth to 8 children without any suspicion of the existence of the deformity having arisen. Sometimes the existence of a double vagina or a double cervix puts one on the alert. The former may occur with a normal uterus, whereas the latter condition almost invariably indicates the existence of a double uterus. When there is only a single cervix, as in uterus bicornis unicollis, the condition always escapes observation, unless the patient is subjected to examination at an early period of pregnancy, and the depression noted between the two halves of the uterus gives a clue to the true state of affairs.

DIVERTICULA FROM UTERINE CAVITY

Freund and Schickele have reported instances in which the pregnancy developed in a diverticulum from the uterine cavity, so that the fœtus lay in a sac surrounded by uterine muscle, and connected with the main uterine cavity only by a narrow passage. It is apparent that such a condition would escape clinical recognition, unless the fingers were introduced into the uterine cavity, and also that it might give rise to serious complications at the time of labor.

A much more common complication is due to a sacculation or to a considerable variation in the thickness and consistency of the uterine walls. In such circumstances, the sacculation may be mistaken for a tumor of ovarian or other origin and the abdomen be opened for its removal. In my experience, it is to the existence of such conditions that many regrettable diagnostic errors are due, and which will occur sooner or later to everyone who practices gynecology and obstetrics.

DISPLACEMENT OF THE UTERUS

Anteflexion.—Exaggerated degrees of anteflexion are frequently observed in the early months of pregnancy, but are usually without significance. In the later months, particularly when the pelvis is markedly contracted or the abdominal walls are very lax, the uterus may fall forward, the sagging being occasionally so exaggerated that the fundus lies considerably below the lower margin of the symphysis pubis. Even in less marked instances of the so-called *pendulous* *abdomen,* the patient may complain of various annoyances, more especially of exhaustion on exertion and dragging pains in the back and lower abdomen. Amelioration of symptoms frequently follows the wearing of a properly fitting abdominal supporter.

Anteversion of the pregnant uterus is occasionally observed in patients who have previously been subjected to operative procedures for the relief of symptoms incident to retroflexion of the uterus, particularly after vaginal fixation, less frequently after an improperly performed ventrosuspension, and now and again after shortening of the round ligaments. The condition is accompanied by marked discomfort during pregnancy, and at the time of labor may give rise to serious dystocia, which will be considered in Chapter XXXII.

Retrodisplacement of the Pregnant Uterus.—Retroflexion and retroversion of the uterus are frequently observed in nonpregnant women, and usually cause more or less inconvenience, though occasionally the condition may exist for years without any abnormal manifestation. In women who have never borne children, the abnormal position of the cervix is supposed to render difficult the access of spermatozoa to the uterine cavity, so that the possibility of conception is considerably diminished. In parous women, on the other hand, the influence is less pronounced, but pregnancy, when it occurs, is prone to early interruption. The abortion is sometimes due to inflammatory, but more often to trophic changes in the endometrium, which are in great part dependent upon abnormalities in the circulation of the displaced uterus.

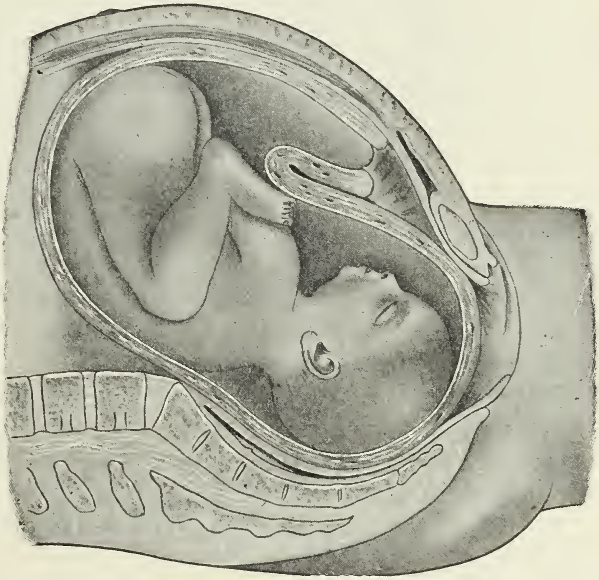

Fig. 502.—Sacculation of Retroflexed Pregnant Uterus (Oldham).

In the majority of cases of pregnancy complicated by retrodisplacements, the uterus was already out of place before conception; although the abnormality may arise during gestation, when it would seem that the enlarged and softened organ is unable to retain the position which it maintained without difficulty when it was of normal size and consistency.

Pregnancy is more frequently complicated by retroflexion than by retroversion, though it is said that the latter tends to give rise to serious symptoms at an earlier period. In either case several eventualities are possible: The displacement may undergo spontaneous reduction without any interruption to pregnancy; abortion may occur; or, if neither takes place, the uterus may become incarcerated in the pelvic cavity and serious consequences follow.

If the displaced uterus is not adherent, spontaneous reduction usually occurs during the third month. This is rendered possible by an eccentric hypertrophy, owing to which the anterior wall undergoes more rapid distention than the posterior, and emerging above the superior strait eventually draws up the rest of the organ. After the fundus has once passed the promontory of the sacrum there is no fear of a recurrence of the condition. Moreover, spontaneous reduction is not wholly out of the question, even when adhesions exist, since they often become stretched and occasionally disappear without treatment. Retroflexion offers better prospects than retroversion; indeed, as Dührssen and Keitler have pointed out, when the latter condition is marked, spontaneous restitution is almost impossible, for the reason that the cervix rises above the symphysis pubis, while the fundus is held back by the promontory of the sacrum.

In rare instances, when the fundus is firmly adherent, pregnancy may remain uninterrupted for a long while. This prolongation is rendered possible by the hypertrophy occurring almost entirely in the anterior wall of the uterus, while the posterior wall fills out the pelvic cavity, and forms a sac in which one pole of the fœtus is retained. This so-called *sacculation of the uterus* has been described in detail by Oldham, Dührssen, and others. Owing to the abnormal position of the cervix and the fact that the presenting part lies far below it, serious difficulties are to be expected at the time of labor, which will be considered in Chapter XXXII.

Abortion is common in pregnancies complicated by retrodisplacements. It usually occurs in the course of the third month, when the growing uterus pretty well fills the pelvic cavity and, becoming irritated by the pressure to which it is subjected, begins to contract, and thus brings about the expulsion of its contents. This termination is particularly likely to occur when the sacrum possesses an exaggerated vertical concavity, since the projecting promontory opposes a serious obstacle to spontaneous restitution.

If pregnancy continues and the displacement is not reduced in the natural course of events, or as the result of manipulations on the part of the physician, the uterus will continue to increase in size until it completely fills the pelvic cavity and, being unable to free itself, becomes impacted, and we have what is known as *incarceration*. Untoward effects, due to pressure, come on sooner in retroversion than in retroflexion, for the reason that in the former the cervix compresses the lower portion of the bladder at an earlier period. Incarceration is accompanied by characteristic symptoms, the woman complaining of pain in the lower portion of the abdomen and back, and disturbances in the functions of the urethra, bladder, and rectum. As the pelvis becomes more and more filled by the growing uterus, the pressure upon the neck of the bladder and urethra becomes so pronounced as to cause retention of the urine with consequent overdistention. Reed, however, holds that the ischuria is not merely mechanical, but is due to compression of the pelvic ganglia by the body of the uterus, with resulting paralysis of the motor nerves of the bladder. But, whatever its cause, when the retention has reached a certain limit, the overstretched viscus squeezes out small amounts of urine at frequent intervals, but never empties itself—*paradoxical incontinence.* If the condition is not soon relieved, the symptoms become more intense, cystitis develops, and the bladder walls become thick and edematous, the urine becomes bloody, and eventually gangrene may result, necrotic portions of the lining membrane of the bladder being cast off and finally expelled through the urethra with severe cramplike pains. In other cases the weakened walls of the bladder are unable to withstand the distention and rupture occurs, followed by a fatal peritonitis.

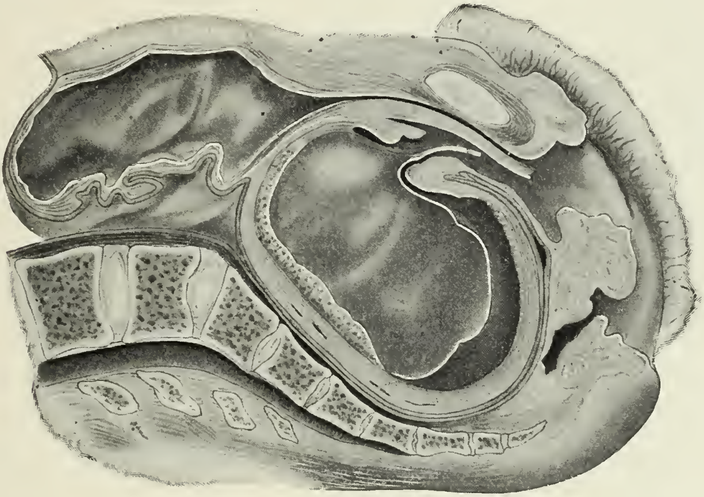

Fig. 503.—Incarceration of Retroflexed Pregnant Uterus (Swytzer).

Occasionally, as the result of the pressure to which it is subjected, the nutrition of the uterus may so suffer that it offers little resistance to bacterial invasion, when it becomes densely adherent to the surrounding parts, while now and again the organ may be forced down and out of the pelvic cavity and emerge through the vulva or anus. In some cases the rectum is compressed to such an extent that defecation becomes impossible and gangrene results. Ileus, however, is an exceedingly rare complication.

Gottschalk found that the following were the most frequent causes of death in 67 cases reported in the literature up to 1894:

Peritonitis of vesical origin	17
Uremia	16
Rupture of the bladder	11
Septicemia of vesical origin	4
Gangrene of the bladder	3

The possibility of a retroflexed pregnant uterus should always be suspected when a woman in the early months of pregnancy complains for any length of time of frequent and painful micturition, especially if there is a history of antecedent uterine trouble. Incontinence of urine during the first half of pregnancy is a most suggestive sign, and always calls for a thorough vaginal examination. With the bimanual method, the soft body of the uterus will be found occupying the pelvic cavity, while the cervix is forced up against the symphysis or lies above it, according as one has to deal with a retroflexion or retroversion. It should be remembered that a pregnant tube lying behind the uterus may give somewhat similar signs, and this possibility should be borne in mind until careful examination has shown that the enlarged uterus does not lie in front of the soft mass.

Treatment.—If the patient receives anything like ideal prenatal care, she should consult an obstetrician shortly after missing the second menstrual period, when a careful pelvic examination should be made. If at that time the uterus is found to be retroflexed, it should be replaced if possible, less on account of the possible development of incarceration later, than as a prophylaxis against the occurrence of abortion. In most instances replacement can be effected by bimanual manipulations, aided by traction upon the cervix by means of a tenaculum or bullet forceps. After reposition, a properly fitting Smith-Hodge pessary should be introduced. On the other hand, if these simple maneuvers fail, the patient should be left alone until well on into the third month, in the hope that spontaneous reduction may occur. If this has not taken place by that time, and symptoms develop, a more determined effort at replacement should be made, with the patient in the knee-chest position. If this proves unsuccessful, reduction can usually be effected by bimanual manipulations under anesthesia. Reposition, however, should never be attempted until after the patient has been subjected to careful bimanual examination, as experience teaches that a tubal pregnancy, which has prolapsed into Douglas' culdesac, sometimes simulates a retroflexed pregnant uterus, when the attempt at reposition leads to its rupture, which usually escapes recognition for some hours, and puts the life of the patient in jeopardy.

When dense adhesions are present, various procedures have been recommended—forcibly breaking them up under anesthesia, attempts to loosen them by means of a succession of vaginal packs, the colpeurynter, or the "watch-spring" pessary, from the use of which Sinclair has reported excellent results. Generally speaking, none of these methods is to be recommended, and, if the uterus cannot be replaced under anesthesia, laparotomy may be performed, the adhesions separated under the guidance of the eye, and the uterus placed in normal position. Such radical interference, however, is very rarely necessary, but in several of my cases it was followed by satisfactory results.

On the other hand, if the patient has not been seen until after symptoms of incarceration have supervened, prompt treatment is imperative. The bladder should be immediately emptied. This cannot always be accomplished with the ordinary female catheter on account of the elongation of the urethra and neck of the bladder resulting from the displacement, so that in many cases a flexible rubber catheter must be employed. Its introduction may often be facilitated by making traction upon the cervix with a tenaculum. After the bladder has been emptied, attempts should be made to replace the uterus—under anesthesia, if necessary. But if this cannot be effected, most authors advise emptying it immediately by dilating the cervical canal. I believe that better results will be obtained in such cases by laparotomy, or by a modified hysterotomy, in which the posterior instead of the anterior portion of the lower uterine segment and cervix is incised. On the other hand, if symptoms of infection or gangrene are present, laparotomy, as recommended by Lobenstine, should not be done, since the weakened and necrotic bladder may be injured, or dense adhesions may be encountered which have formed over the uterus, practically shutting it off from the abdominal cavity and rendering the freeing of it almost impossible. Under these circumstances the obstetrician should content himself with emptying the uterus per vaginam in the most conservative manner, and then rely upon palliative treatment.

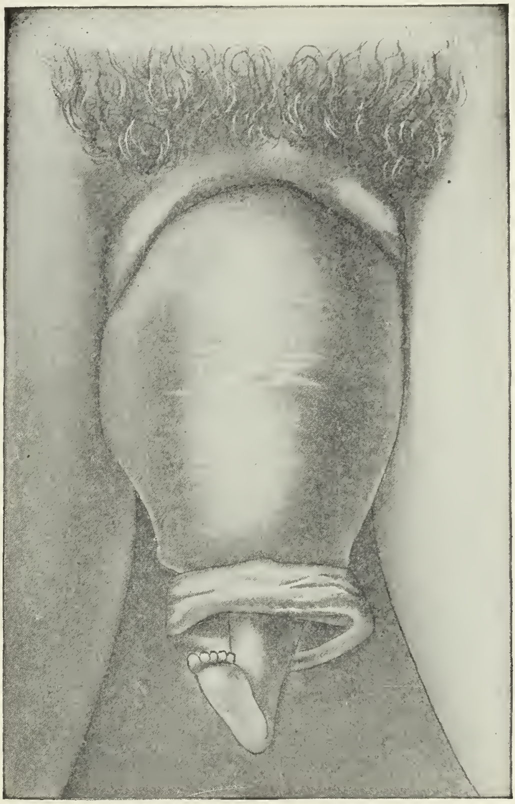

Fig. 504.—Prolapsed Pregnant Uterus (Wagner).

Lateral Displacement of the Pregnant Uterus.—Slight degrees of lateral displacement of the uterus during pregnancy are relatively frequent, but usually have no effect upon its course and do not give rise to symptoms. It should, however, be borne in mind that in the early months similar conditions are sometimes mistaken for tubal pregnancy.

Prolapse of the Pregnant Uterus.—Impregnation in a totally prolapsed uterus is very rare on account of the difficulties attending a successful coitus, but is comparatively frequent if the prolapse is only partial. In such cases the cervix, and occasionally a portion of the corpus, may protrude to a great or lesser extent from the vulva during the early months, but as pregnancy progresses the body of the uterus gradually rises up in the pelvis, and draws the cervix up with it, so that as soon as the former has passed above the superior strait, prolapse is no longer possible. On the other hand, if the uterus retains its abnormal position, symptoms of incarceration appear during the third or fourth month, and abortion is the inevitable result, there being no cases on record in which pregnancy has progressed to term with the uterus outside of the body.

If there is a tendency toward prolapse during pregnancy, the uterus should be replaced and held in position by a suitable pessary. If, however, the pelvic floor be too relaxed to permit its retention, the patient should be kept in a recumbent position as far as possible until after the fourth month. When the cervix reaches to or slightly protrudes from the vulva, the greatest cleanliness is necessary, as instances of fatal infection have been reported as occurring even without any internal examination. If the uterus persistently lies outside of the vulva and cannot be replaced, it should be emptied of its contents.

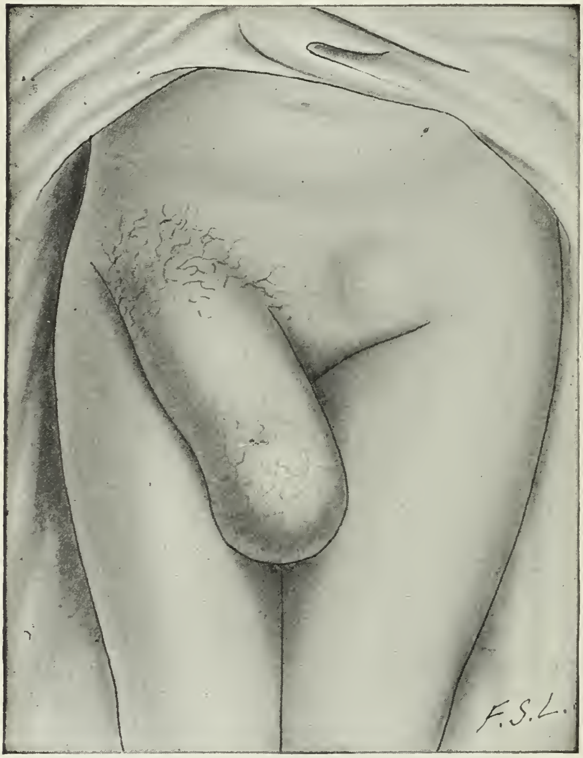

Fig. 505.—Pregnancy in Horn of Uterus Contained in Inguinal Canal (Eisenhart).

When the vaginal outlet is markedly relaxed, the congested anterior or posterior vaginal walls sometimes prolapse during pregnancy, although the uterus may still retain its normal position. This condition may give rise to considerable discomfort and interfere with locomotion. It is not amenable to treatment until after delivery. At the time of labor these structures may be forced down in front of the presenting part and interfere with its descent. When this occurs they should be carefully cleansed and pushed back over it.

In rare instances a hernial protrusion may occur through the vagina, the anterior or posterior wall forming part of the sac. Such a *vaginal enterocele* may form a tumor of considerable size filled with intestines. Hirst has collected 27 instances from the literature. If the condition occurs during pregnancy, the protrusion should be replaced and the patient kept in the recumbent position. At the time of labor it may seriously interfere with the advance of the head. In such cases the mass should be pushed up if possible, and, when this cannot be done, it should be held out of the way as well as may be, and the head delivered past it.

Hypertrophic Elongation of the Cervix.—An abnormally elongated cervix seriously interferes with the occurrence of conception, but, as a rule, does not complicate the course of pregnancy or labor. The canal usually becomes shorter and more dilatable as term is approached. In one of my patients the vaginal portion of the cervix in the early months was 5 centimeters in length and the external os protruded from the vulva, whereas later it had undergone marked softening and become reduced to normal dimensions, so that labor occurred spontaneously.

Acute Edema of the Cervix.—In very rare instances the cervix, particularly its anterior lip, may become so acutely edematous during pregnancy and attain such proportions as to protrude from the vulva. This condition is referable to an angioneurosis, and, if not associated with preëxisting hypertrophy, may, on rest in bed, disappear almost as suddenly as it developed. Jolly was able to collect 10 cases from the literature, which were increased to 24 by Hunter in 1927.

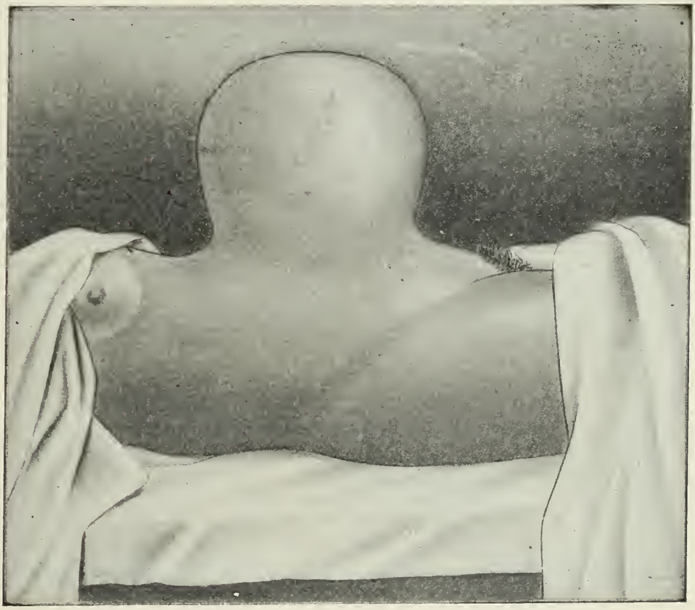

Fig. 506.—Hernia of Pregnant Uterus (Adams).

Hernia.—Pregnancy occurring in women suffering from *inguinal hernia* is not influenced by the condition, although, owing to the increased intra-abdominal pressure, the previous defect may become aggravated. Generally speaking, the hernia should be treated palliatively by rest and the use of a truss, operative treatment being deferred until after delivery. Very exceptionally, the uterus may form part of the contents of an inguinal hernia, and, indeed, several cases are on record in which conception has occurred under such circumstances. Full literature upon the subject will be found in the articles of Adams and Eisenhart, the latter having reported a case in which one horn of five months' pregnant bicornuate uterus occupied the right inguinal canal.

Umbilical herniæ are frequently noted during pregnancy, but are usually without effect upon the condition. During the early months the uterus is not in the neighborhood of the hernial opening, while later, when the fundus reaches its level, it is usually too large to gain access to it; but when the abdomen is markedly pendulous, such an occurrence is not beyond the range of possibility, and several such instances are on record. Much more common are the cases in which the cicatrix of an abdominal incision yields to the increased intra-abdominal pressure incident to pregnancy, and along the linea alba is formed a hernial sac into which the pregnant uterus often makes its way, being then covered merely by a thin layer of skin, fascia, and peritoneum.

A similar condition is occasionally observed in women suffering from extensive *diastasis of the recti muscles.* Figure 506 represents a patient in whom a hernia of this kind occurred suddenly during labor. Ordinarily, such herniæ have no effect upon pregnancy, although they may add markedly to the discomfort of the patient. Temporary relief is frequently obtained by holding the uterus in its normal position by a properly fitting bandage. At the time of labor, owing to the loss of muscular tone in the abdominal walls, the second stage is liable to be prolonged, and the employment of forceps is often called for. Such herniæ should be repaired during the later weeks of the puerperium.

DISEASES OF THE DECIDUA

In nonpregnant women the endometrium is frequently the seat of lesions which are grouped together clinically under the general heading of *endometritis.* Histological examination shows, however, that the term is usually a misnomer, as the changes are generally trophic, rather than inflammatory in character, and in many instances merely represent phases of the menstrual cycle. The most important varieties are classified as follows:

Hyperplastic endometritis—general hyperplasia, localized hyperplasia, polypoid growths.

Glandular endometritis—glandular hyperplasia.

Interstitial endometritis—general hypoplasia.

Acute and subacute endometritis—"true" endometritis.

These conditions are prototypes of more or less similar lesions occurring in the decidua, except, of course, that the latter are modified by the histological characteristics incident to pregnancy.

In the vast majority of inflammatory cases, as was first pointed out by Veit, the decidual affection represents the extension of a lesion already existing prior to pregnancy, conception occurring in a uterus affected by infective endometritis. In rare cases, however, the condition may originate during pregnancy, and particularly following the attempts at criminal abortion.

It is generally believed that endometritis is necessarily associated with sterility, the abnormal secretion interfering with impregnation, and, even if conception occurs, the diseased mucosa does not offer a favorable nidus for the implantation of the ovum. Generally speaking, this belief is justified only when the endometrium is the seat of an acute inflammatory process, and every physician can recall instances in which sterility has persisted until more or less normal conditions were restored. On the other hand, slight degrees of chronic endometritis, or of hyperplastic conditions, do not, as a rule, interfere with conception.

Diffuse Thickening of the Decidua.—Hegar, Kaltenbach, Kaschewarowa, and more recently Riotte have described a general hyperplasia of the decidua, in which the membrane, instead of becoming thinner, as is generally the case after the first few months, assumes unusual proportions and is abundantly supplied with large blood vessels. The condition may result in abortion, as a large part of the nutritive material intended for the fœtus is diverted to nourishing the decidua; while in other cases it may give rise to slight antepartum bleeding, and suggest the existence of premature separation or placenta prævia. After abortion or labor, thickened decidua may cause abnormalities in the separation of the placenta.

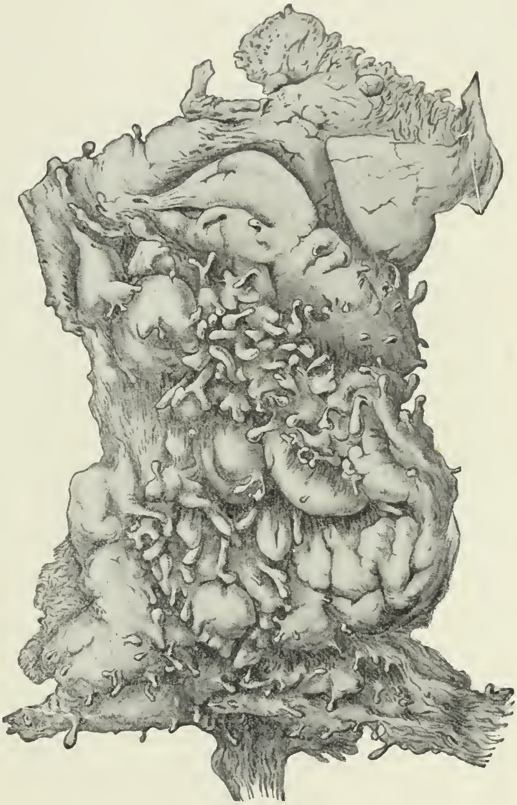

Fig. 507.—Decidua Polypsa (Bulius).

In other cases, the thickening is more or less localized—*decidua polyposa.* In this affection, the characteristic feature consists in the projection of irregularly shaped knoblike masses from the inner surface of the decidua. Virchow first described this condition as decidua tuberosa or polyposa, and considered it to be syphilitic in origin, which, however, is rarely the case. Ahlfeld states that it is frequently observed, and Nyulasy of Melbourne has noted more than 100 cases in his own practice. Bulius holds that it occurs but rarely, and I have never met with an instance.

Glandular Hyperplasia of the Decidua (*Endometritis Decidua Glandularis*).—Occasionally marked hyperplasia of the glandular structures of the decidua is present, and is usually associated with persistence of the glandular ducts. This affection commonly manifests itself by a profuse secretion of clear fluid, which may dribble away as rapidly as it is produced, or be retained in the uterus to be suddenly discharged in large quantities at variable intervals—*hydrorrhea gravidarum.* The amount of fluid expelled varies considerably, though Ahlfeld has reported a case in which it exceeded 500 cubic centimeters on several occasions. This condition precludes the fusion of the decidua vera and capsularis, and therefore in the occasional instances in which it continued throughout pregnancy it must be assumed that these structures had failed to unite as usual.

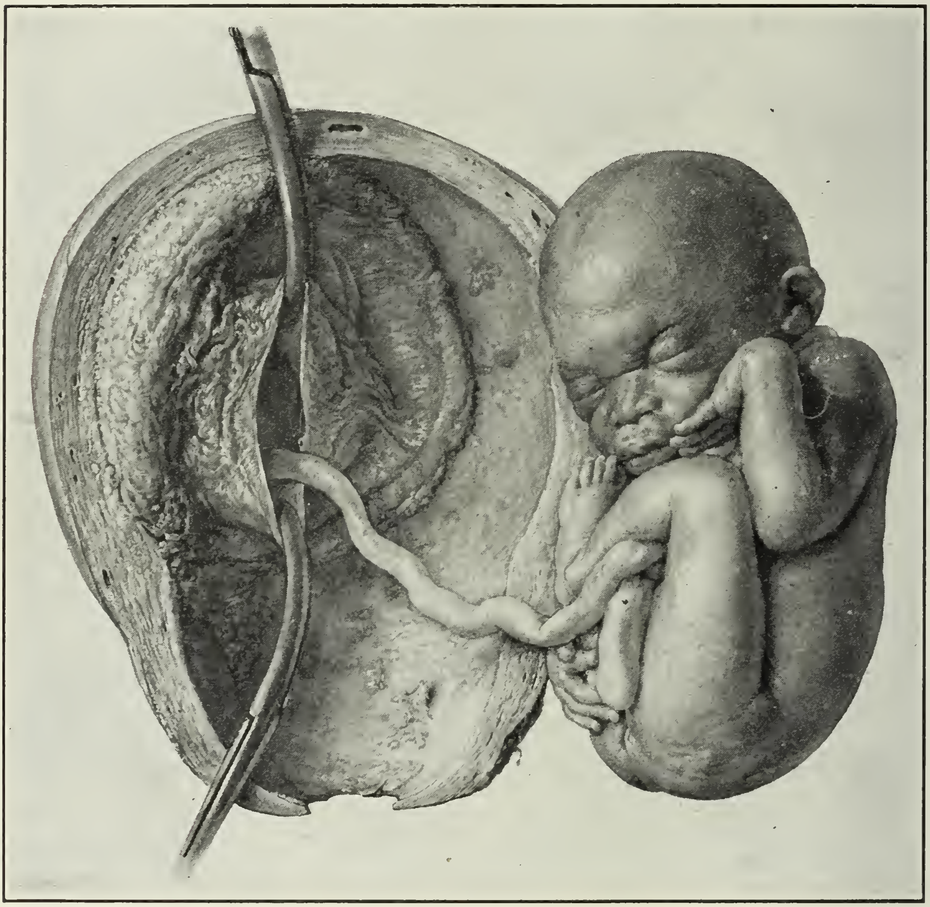

Fig. 508.—Extramembranous Pregnancy (Hofbauer). × 3/5.
Note collapsed fœtal membranes held apart by clamps.

Since 1899, considerable discussion has arisen concerning the nature of hydrorrhea gravidarum. Stoeckel, Meyer-Ruegg, and other authorities believe that it does not result from changes in the decidua, but is due to premature rupture of the fœtal membranes, which then collapse upon the fœtal surface of the placenta so that the child comes to lie free in the uterine cavity—in other words, the pregnancy becomes extramembranous, while amniotic fluid continues tc be secreted and escapes in an intermittent trickle. Figure 508 is an excellent illustration of the condition, and shows that the amniotic cavity has retracted to such an extent as to become almost negligible. In other cases, the membranes may develop a small defect, but still surround the fœtus.

Meyer-Ruegg, in 1904, was able to collect from the literature 15 cases of hydrorrhea in which a period varying from fifty to one hundred and twenty days had elapsed between the rupture of the membranes and the termination of pregnancy. Van der Hoeven inclines to the older view, and bases his belief upon the chemical analysis of the fluid expelled. Where the fluid escapes in sufficient quantity to be collected, its amniotic origin can be demonstrated by finding lanugo hairs on microscopic examination after centrifugalization.

In rare cases the openings of the uterine glands may become occluded, small retention cysts being formed which project from the surface of the decidua, giving it a nodulated appearance. The affection has been described by Hegar, and Breus as *endometritis cystica*.

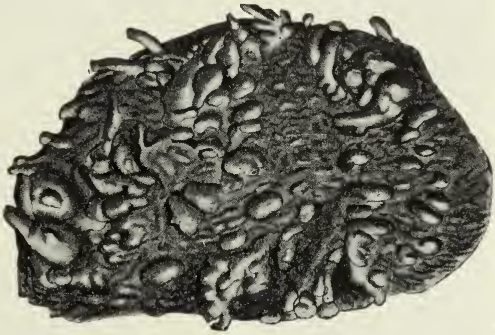

Fig. 509.—Endometritis Decidua Cystica (Breus).

Atrophic Endometritis Decidua.—Under this heading Hegar, Ahlfeld, and others have described a disease in which large portions of the decidua vera and basalis undergo atrophic changes similar to those which normally occur outside of the placental site after the third month. They offer no suggestion as to its etiology, but consider that it may interfere with the nutrition of the ovum and is a frequent cause of abortion. It should be remembered, however, that the etiological significance of such a condition must be limited to the weeks immediately following implantation; as it often happens in the later months of pregnancy that the decidua basalis becomes reduced to a fraction of a millimeter in thickness without interfering in any way with the progress of pregnancy. On the other hand, a primary defect in the development of the decidua may result in such imperfect nidation that the ovum perishes, or, if the pregnancy continues, the proliferating villi may extend into the underlying muscularis and thus give rise to a placenta accreta.

Acute Endometritis Decidua.—Acute inflammatory lesions of the decidua frequently follow attempts at criminal abortion, though now and again they may be due to a perpetuation of conditions existing prior to conception, as described by Hartmann, as well as occasionally to primary infection before fusion of the decidua capsularis with the vera has occurred. Reference has already been made to the lesions of the endometrium associated with gonorrhea and occasionally with acute infectious diseases.

In many instances I have been able to demonstrate the presence of cocci or bacilli in sections, and occasionally in cultures. These observations prove beyond doubt the bacterial origin of the lesions, but in cases of abortion it is very difficult to decide whether the inflammatory process is primary or secondary. Generally speaking, the latter is probable whenever the course of the abortion has been prolonged. In these cases the decidua vera and basalis are thickened and their external surface covered with a yellowish purulent exudate. Under the microscope the tissue is found to be infiltrated with leukocytes, and plasma cells and presents the typical picture of acute inflammation, with here and there areas of necrosis.

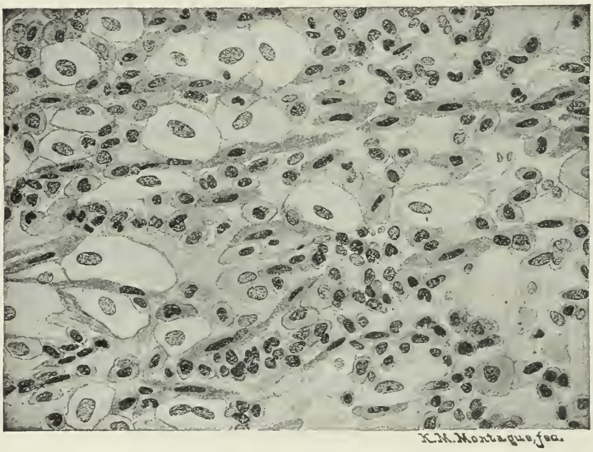

Fig. 510.—Decidual Endometritis. × 280.

Maslowsky, Neumann, myself and others have been able to demonstrate the presence of gonococci in acute inflammation of the decidua; and it is probable that such conditions are quite common.

Formerly it was thought that the various forms of endometritis decidua were the most important factor in the causation of spontaneous abortion, but greater experience indicates that it is not the case, and that fundamental defects in the germ plasm are of greater importance. The existence of some decidual lesion should be suspected whenever the patient complains of a sensation of weight in the lower abdomen associated with a slightly bloodstained or dirty brownish discharge, particularly when there is history of gonorrheal infection or of repeated abortions which were not associated with palpable lesions of the generative tract or defects of the ova. Furthermore, it is permissible to assume that the atrophic abnormalities of the decidua may play a part in the production of placenta prævia, by making it necessary for the organ to establish a wide area of attachment.

Endometritis is not amenable to treatment during pregnancy. Should the patient present the slightest sign of its existence after abortion or childbirth, appropriate measures should be promptly instituted, since the condition frequently persists and may become seriously aggravated in a subsequent pregnancy.

Metritis.—Unless it results from infection, metritis is a very rare complication of pregnancy, and when it exists was usually present before conception. It predisposes to abortion and is not amenable to treatment during pregnancy.

Peri-uterine Inflammation.—When pregnancy occurs in women suffering from peri-uterine inflammation, considerable discomfort may result from the stretching of old adhesions. Not uncommonly abortion results. Now and again the inflammatory changes undergo exacerbation during pregnancy, and may eventuate in abscess formation, which is accompanied by the usual symptoms of pelvic peritonitis. Very exceptionally rupture may occur and give rise to acute peritonitis, which can be successfully combatted only by radical operative measures.

Pregnancy Complicated by Tumors.—Pregnancy is occasionally complicated by the presence of ovarian or uterine tumors. Although, as a rule, they do not materially affect its course, they frequently give rise to serious dystocia at the time of labor, and will therefore be considered in detail in Chapter XXXII.

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CHAPTER XXVIII

DISEASES AND ABNORMALITIES OF THE OVUM

Any portion of the ovum—chorion, amnion, placenta, or fœtus—may be the seat of disease, or may present abnormalities. In many instances the morbid process is limited to a single portion, while in others a large part, or even the ovum as a whole, may be implicated. Accordingly, we shall take up successively those lesions or abnormalities which are limited to the chorion, amnion, or placenta; next, those in which the entire ovum and finally those in which the fœtus alone is affected.

DISEASES OF THE CHORION

Hydatidiform Mole.—In this condition, also known as vesicular mole, cystic degeneration of the chorion, or myxoma chorii, the terminal extremities of the chorionic villi are converted into transparent vesicles with clear, viscid contents. These vary in size from minute bodies a millimeter or less in diameter to cystic structures the size of hazelnuts, and hang in clusters from the villous stems, to which they are connected by thin pedicles, giving to the external surface of the chorion a grapelike appearance. The formation usually involves the entire periphery of the membrane, but may be limited to portions of it.

It is generally stated that the condition was first described by Schenck von Gräfenberg, in 1565, but Kossmann has pointed out that Aëtius, of Amida, in the early part of the sixth century, wrote intelligently about an hydatidiform mole, although he seemed to have no clear idea of its nature.

Owing to its peculiar appearance and the fact that it frequently contains no trace of a fœtus, the hydatidiform mole was a source of not a little speculation to the early writers upon medicine, and all sorts of theories were advanced concerning its origin. As the name implies, the condition was long considered to be analogous to the hydatid cysts observed in other parts of the body. Goeze, Percy, and others believing that the vesicles contained wormlike structures. De Graaf held that the vesicles were mature ova, while some authors thought that each represented an early pregnancy. It is probable that some of the extraordinary cases of multiple gestation recorded in the early literature, such as that of the Countess Hagenau, who was believed to have given birth to 365 embryos at a single labor, were really instances of hydatidiform mole.

The true nature of the affection was first recognized by Velpeau and Madame Boivin, in 1827, and since then it has been universally admitted to be a disease of the chorion. Numerous theories were advanced as to the nature of the lesion, until Virchow, in 1853, stated that the process was essentially a myxomatous degeneration of the connective tissue of the chorionic villi, and designated it as *myxoma chorii*. This view obtained immediate acceptance and held its ground until 1895, when Marchand demonstrated that the essential feature of the affection was to be found not so much in the stroma as in the epithelial covering of the villi. He showed that both the syncytium and Langhans' layer of cells undergo profuse and irregular proliferation, penetrating Nitabuch's fibrin layer and making their way into the depths of the decidua, and occasionally into the uterine musculature as well. At the same time the blood vessels of the terminal villi disappear and the stroma degenerates, giving place to a central cavity filled with fluid, surrounded by a margin of necrotic connective tissue, whose cells fail to take up the usual histological stains. Moreover, inasmuch as the fluid contents of the vesicles fail to give the characteristic reaction for mucin, Marchand felt justified in attributing them to edema.

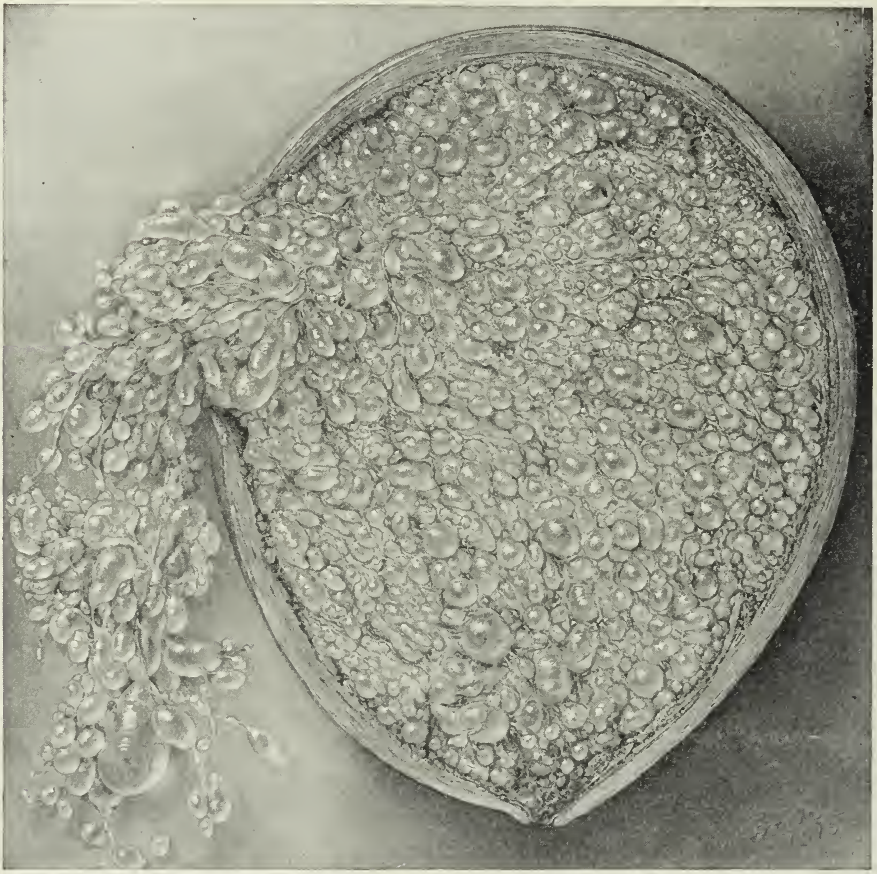


Fig. 511.—Uterus Removed by Supravaginal Hysterectomy, Containing a Hydatidiform Mole. × ½.

This work obtained almost immediate acceptance, and was promptly confirmed by many investigators, among whom Neumann, Fraenkel, Pick, Larrier and Brindeau, Essen-Möller and R. Meyer may be mentioned. Figure 512 represents a section through one of my specimens, all of which abundantly confirm Marchand's view. In rare instances the abnormality may develop in tubal pregnancies, and Essen-Möller and Als-Neilson have even described a case developing in the ovary.

With the discovery that the so-called chorionepithelioma resulted from a malignant proliferation of the epithelial elements of the chorion, and particularly that it was preceded in from one third to one half of the recorded cases by the expulsion of an hydatidiform mole, great interest arose as to the relation which the latter bore to the production of the former. The similarity in the microscopic structure of the two pathological processes made it apparent that there must be a genetic relationship between them, and the question arose whether it existed in all cases.

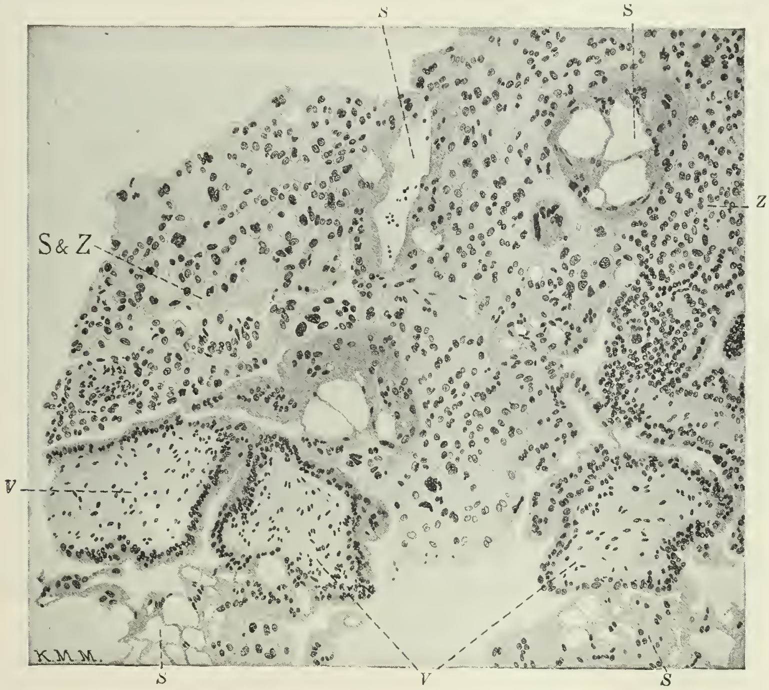


Fig. 512.—Section of Hydatidiform Mole, Showing Proliferation of Syncytium and Langhans' Cells. × 75.
S., syncytium; *V.*, normal chorionic villi; *Z.*, Langhans' cells.

Neumann, in 1897, held that it was possible to differentiate between two forms of hydatidiform mole, one of which was and the other was not followed by the development of a chorionepithelioma. He considered that in the former the proliferating epithelium invaded the stroma, while in the latter it was limited to the periphery of the villus. His observations, however, have not been confirmed, and neither Robert Meyer nor I have been able to predict the eventual outcome from the histological structure of the original mole. On the other hand, various writers, such as Pick, Findley, and Larrier and Brindeau, hold that essential differences do occur, but, as they are biological rather than anatomical, it is impossible to differentiate them by histological means.

Marchand, in his original article, stated that in many instances the ovaries are likewise the seat of cystic changes. Stoeckel, in 1902, showed that one or, more commonly, both ovaries may become converted into polycystic tumors, which sometimes attain a diameter of 10 or 15 centimeters. The individual cysts vary from a few millimeters to 5 or 6 centimeters in diameter, are filled with clear contents, and are lined by one or more layers of lutein cells. Since then it has become generally recognized that the lutein cell cystoma is a frequent, but not a universal, accompaniment of the condition.

As lutein cystomata do not occur frequently, their association with hydatidiform mole has given rise to a great deal of discussion, certain writers holding that they stand in some etiological relation to the mole; others that they are secondary to it; while a third group, represented by Wallart and Seitz, considers that the process represents an exaggeration of theca lutein cell proliferation which characterizes normal pregnancy. The fact that only a certain proportion of hydatidiform moles are associated with lutein cystomata speaks strongly against the assumption that the latter play an etiological rôle. On the other hand, the demonstration by Fraenkel, and Santi, that such tumors undergo spontaneous involution within a few months after the expulsion of the mole, indicates that there must be some genetic relationship between the two processes. In one of my patients, both ovaries were converted into cystomata the size of large oranges, and yet, upon examination three months after the extrusion of the mole, all trace of them had disappeared and the ovaries were found to be normal in size.

Causation.—Positive statements cannot as yet be made concerning the etiology of hydatidiform mole. Virchow and Veit held that it was dependent upon endometritic changes. At the 1901 meeting of the German Gynecological Congress Aichel stated that he had been able to produce the condition experimentally in dogs by destroying the vessels going to the decidua, but, in view of the fundamental difference in structure between the zonal placenta of carnivora and the discoidal placenta of man, the greatest caution should be exercised in making inferential deductions. On the other hand, Marchand and most recent writers consider the changes in the endometrium as secondary, and seek the initial factor in the ovum itself. Durante considers that the condition is due to endarteritis of the villous vessels. Plausibility is lent to the view that the primary process originates in the ovum by the fact that in rare instances of twin pregnancy one ovum may be normal, while the other presents the lesion in question. Madame Boivin was acquainted with this fact, and cases have been reported by Birnbaum, Falgowski, Lukens, and others. It is hardly probable, if changes in the endometrium were the primary cause, that the vesicular change would be limited to one ovum.

Observations by De Snoo and Aschheim, as well as by Philipp in our clinic, show that in hydatidiform mole there occurs a great increase in the pregnancy hormone (folliculin), as indicated by a striking increase in the toxicity of the urine when injected into experimental animals. Furthermore, Aschheim, from the similarity between changes occurring in the ovaries in cases of hydatidiform mole, and those developing in the ovaries of immature mice following the implantation of fragments of hypophysis, suggests that the condition may be due to increased activity of that gland. However that may be, I am inclined to believe that the ovarian changes are due to an increased production of hormones by the proliferating chorionic epithelium, and base that belief upon the fact that Philipp found that the subcutaneous implantation of small hydatidiform vesicles into immature mice caused death, whereas the implantation of particles of normal human placenta of similar size merely led to pronounced activity of the ovaries and to premature œstrus. Whatever the significance of these observations may be, they are of great interest, as they indicate that underlying the striking histological changes accompanying this condition are biological processes of still greater significance.

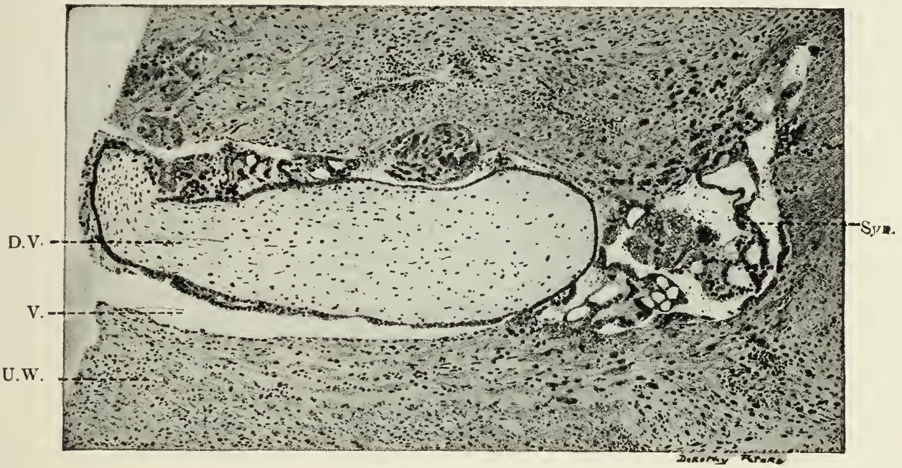


Fig. 513.—Hydatidiform Mole. × 50.
Invasion of blood vessel. *D. V.*, dropsical villus; *Syn.*, proliferating syncytium; *U. W.*, uterine wall; *V.*, vein.

Clinical History.—Hydatidiform mole is a rare disease, occurring, according to Madame Boivin, once in 20,000 pregnancies. On the other hand, the statistics of Williamson, and Sunde would indicate that it may be found about once in 2400 or 3000 cases; while in my experience it occurs even more frequently. It may occur at any period of reproductive life, but is particularly frequent in the third and fourth decades, having been noted between the twentieth and thirtieth years in 41 and 38 per cent of the cases collected by Dorland and Kehrer, respectively. Sunde, on the other hand, on the basis of 122 personally investigated cases, holds that it occurs two and a half times more frequently after the fortieth year if the total number of pregnancies is considered.

The statement of Meyer that the disease was present in over 100 out of 348 specimens of abortion, which he examined, should not be accepted without reservation. He referred to degenerative changes in the stroma of the villi, which are associated with fœtal or embryonic death; while in hydatidiform mole one has to deal with an active hyperplasia of the chorionic epithelium. Doubtless he is correct, so far as he goes, but he was not dealing with true hydatidiform moles.

The process usually comes on early in pregnancy, rarely making its appearance after the third month, and was present in one of my specimens thirty-eight days after the last menstrual period. When it develops comparatively late it does not implicate the entire chorion; but whenever a considerable portion of the membrane is involved, the embryo is usually lacking, and its development is materially influenced even when the lesion is relatively restricted. As the chorionic villi are nourished by the maternal blood, the mole may continue to grow after the death of the embryo, and may attain considerable proportions, though spontaneous expulsion is rarely delayed after the sixth month.

The clinical history is very characteristic. The uterus enlarges much more rapidly than usual, so that its size does not correspond to the supposed duration of pregnancy. This was formerly considered a general rule, but the tabulations of Briggs and Essen-Möller show that in many instances the uterus is smaller than would be expected. After a longer or shorter period more or less profuse hemorrhage occurs, which persists until the mole is cast off spontaneously or removed by the physician.

In a small number of cases, the hypertrophic villi invade the uterine wall, following the course of venous channels, and in extreme instances the entire muscularis may become disintegrated. This happens in what is known as the destructive mole, characteristic examples of which have been reported by Krieger, Volkmann, Jarotsky, and Waldeyer and more recently by Johansson. Now and again the growth reaches the peritoneal surface of the uterus and gives rise to perforation, followed by fatal intraperitoneal hemorrhage. This complication was observed by Wilton, Madame Boivin, Ouvry, and others.

In rare instances, at varying periods after the expulsion of the mole, small purplish or reddish tumors may appear in the vagina or about the vulva. On microscopic examination, after excision, these are found to consist for the most part of blood, through which are scattered dropsical villi showing the characteristic epithelial changes. In a number of cases recorded, the uterus was normal, and complete excision of the nodule was followed by permanent recovery. The question has accordingly arisen whether such tumors represent metastases from a chorionepithelioma or a malignant hydatidiform mole, or whether they are merely due to the accidental transportation of particles of a benign growth. The observations of Veit, Poten and myself concerning the transportation of villi in normal pregnancy (Fig. 513), but more particularly the observations of Pick, Schlagenhäufer, and Liebe that cure has followed their excision, speak in favor of the latter view.

Aside from the possibility of the development of a chorionepithelioma, which occurred in 16 per cent of the 210 cases analyzed by Findley, but only in 5 per cent of the cases studied by Sunde, the hydatidiform mole is a serious affection, since Dorland noted an immediate mortality in 10 per cent of the 100 instances which he collected from the literature, death being due to hemorrhage at the time of operation in 3 per cent, to perforation of the uterus in 2 per cent, and to infection in 5 per cent of the cases. Sunde has pointed out that the occurrence of hydatidiform mole has no effect upon subsequent fertility, although Essen-Möller has shown that it may recur in successive pregnancies, and has collected 18 illustrative cases from the literature.

As was indicated in the chapter upon the toxemias of pregnancy, the growth may in rare instances be associated with preëclamptic toxemia, and Figure 511 represents a mole within a uterus which had been removed because of that complication.

Diagnosis.—Hydatidiform mole should always be suspected when hemorrhage occurs in a patient over thirty years of age whose uterus is considerably larger than it should be for the supposed duration of pregnancy, though in not a few cases similar symptoms are noted in hydramnios. A positive diagnosis may be made when one finds one or more vesicles in the uterine discharges, or when the finger is introduced through the cervical canal is able to palpate the characteristic grapelike masses.

Treatment.—Owing to its inherent danger, but especially to the possible subsequent development of a chorionepithelioma, the uterus should be emptied as soon as a positive diagnosis is made. By means of a gauze pack or a steel dilator, the cervix should be dilated sufficiently to admit two fingers, with which the growth is peeled off from the uterine wall and then removed. Care should be taken that the manipulations are made as gently as possible in order to avoid a possible perforation of the uterus, whose walls are likely to have been weakened by the invasion of the growth. After removal of the mole, the uterine cavity should once more be explored to make sure that it is thoroughly empty.

In view of the danger inherent to this abnormality, Schumann has advised opening the uterus by abdominal hysterotomy, and removing it, or sewing it up after the removal of its contents, according to the conditions found. I consider his recommendation unduly radical, and feel sure that it will lead to the unnecessary sacrifice of many uteri. At the same time, I favor routine hysterectomy whenever the condition develops in women at the end of the period of sexual activity. If accompanying lutein cystomata are diagnosticated, they should not be removed, as it has already been indicated that they will undergo spontaneous involution within a short time after the extrusion of the mole.

Every woman who has expelled a hydatidiform mole should be carefully watched during the following year, and if hemorrhage makes its appearance the uterus should be curetted and the scrapings subjected to microscopic examination; and, if the lesions characteristic of chorionepithelioma are found to be present, immediate hysterectomy is imperative, in the hope of avoiding metastases. On the other hand, as has already been pointed out, vaginal or vulval metastases may occur without any apparent involvement of the uterus. Under such circumstances, the mestastases should be excised, but the uterus left in place, as the history of similar cases shows that the majority of the patients recover permanently.

Chorionepithelioma.—This term is applied to a very malignant variety of tumor which develops after full-term labor, abortion, or hydatidiform mole, and in rare instances even before the last is expelled from the uterus. The nature of the growth has given rise to a great deal of discussion, and various appellations have been suggested for it, the most important being deciduoma malignum, sarcoma deciduocellulare, syncytioma malignum, and carcinoma syncytiale.

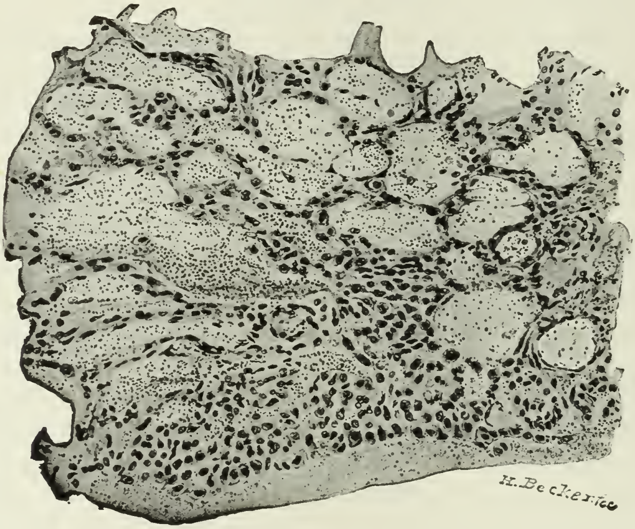


Fig. 514.—Chorionepithelioma, Showing Alveolar Arrangement of Primary Tumor. × 60.

The first case was described in 1892 by Sänger, who based his article upon the following case: A woman, twenty-three years of age, aborted in the eighth week and died seven months later. At autopsy four large, soft, reddish, spongy tumors were found in the uterine wall, with metastases exhibiting similar characteristics in the lungs, diaphragm, tenth rib, and right iliac fossa. Microscopic examination showed that the tumor was made up in great part of blood spaces bounded by large cells, which were considered decidual in origin. The metastases presented a similar appearance and had resulted from the transportation of tumor masses through the venous channels. As Sänger believed that the tumor was derived from decidual cells and was therefore of connective-tissue origin, he designated it *decidual sarcoma* or *sarcoma uteri deciduocellulare*. The appearance of his monograph, in 1893, in which was collected all that was then known upon the subject, created profound interest, and was soon followed by the publication of many similar cases.

In 1895, I published a monograph upon the subject, in which I reported a case and collected 24 others from the literature. My patient was a colored woman, who, one week after a spontaneous full-term labor, noticed a small painful nodule upon the right labium majus. This resembled a hematoma in appearance, rapidly increased in size, and within two weeks became as large as a hen's egg. Shortly afterward it underwent necrotic changes, which were accompanied by a profuse, foul-smelling discharge. The patient gradually grew worse, eventually developed a cough and bloody expectoration, and died six months after delivery. The nature of the vulval tumor was not suspected during life, but at autopsy the lungs were found to be studded with large numbers of metastases of varying size, which resembled placental tissue in appearance. Similar growths were present in the kidneys, spleen, and ovary, while the primary uterine tumor was a small nodule about 1 centimeter in diameter.

Microscopic examination showed that the uterine growth and the metastases were made up in great part of blood spaces, whose walls were formed by large clear cells with definite vesicular nuclei. At the margins of the primary growth, invading the adjacent musculature, were large masses of syncytium; the nature of the individual cells was not so clear, although I was inclined to consider them due to transverse and oblique sections through the syncytial strands.

While my article was in preparation, the important monograph of Marchand appeared. He identified the protoplasmic masses with the syncytium, and the individual cells with those of Langhans' layer. At that time it was generally believed that the former was of maternal and the latter of fœtal origin; accordingly he held that the tumor was epithelial in origin, and was composed partly of maternal and partly of fœtal tissue. Hence it followed that such tumors could not correctly be described as deciduomata or decidual sarcomata. Three years later, after it had been demonstrated that both layers of the chorionic epithelium were fœtal in origin, he proposed the term *chorionepithelioma*, which has since been generally accepted.

The monographs of Sänger, Marchand and myself were the beginning of an extensive literature upon the subject, which has rapidly increased in volume. Thus, Teacher, and Briquel, in 1903, were able to collect 188 and 254 cases respectively, which Vineberg increased to 533 in 1917. Robert Meyer, in 1927, was able to discuss 21 cases which he had studied personally.

Risel, working in Marchand's laboratory, contends that chorionepithelioma may occur in a typical and an atypical form. In the former the tumor cells present an appearance identical with that presented by the chorionic epithelium in early pregnancy, while in the latter the fœtal cells merely infiltrate the uterine wall, without necessarily giving rise to a true tumor formation. Both varieties are equally malignant and give rise to metastases.

In other instances, the primary growth may originate outside of the uterus. Thus, in 1914, Risel was able to collect 22 cases in which it had originated in the tube, and Sunde, Klein and I have observed additional instances; while Fairbairn, Klotz, Risel, Seitz, and others have reported cases in which it developed in the ovary. In the latter instance one's first tendency would be to associate the condition with an ovarian pregnancy or with a teratoma, but, while such an origin cannot be denied, Risel believes that in most cases the ovarian tumor is derived from a primary uterine growth, which had long since disappeared. In still other cases, as reported by Schmorl, Hübl, Findley, and others, there was no trace of a primary growth in the uterus, tubes, or ovaries, but the patient nevertheless died from metastases in various organs. At first it was attempted to explain such an occurrence by assuming that the primary growth had been limited to the placenta, particles of which became broken off and were carried into the circulation, giving rise to metastases, while the primary tumor itself was cast off with the after-birth. Later, however, as the frequency of the "deportation" of chorionic villi became more fully recognized, it was assumed that metastases might develop in any case in which the chorionic epithelium possesses malignant properties. Poten and Vassmer have reported a case in which vaginal metastases appeared while an hydatiform mole was still present in the uterus.

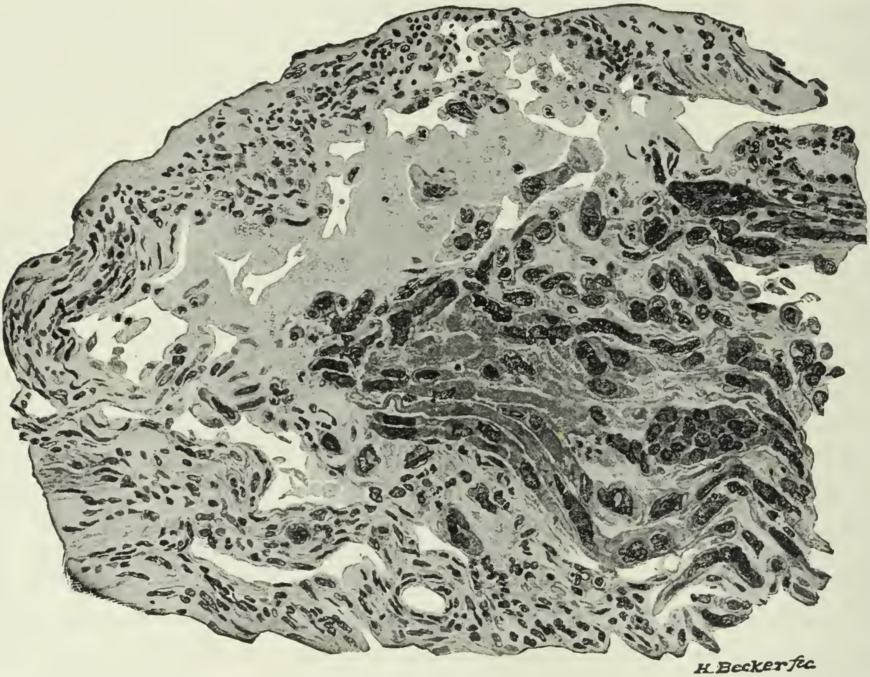


Fig. 515.—Chorionepithelioma, Showing Syncytial Masses Invading a Venous Channel.

The chorionepithelioma rapidly gives rise to abundant metastases, particularly in the lungs, vagina, and brain. They develop along the course of venous channels, which is explained by the tendency of the fœtal ectodermal cells to arrode, and eventually invade, the blood vessels with which they come in contact.

In the 52 cases collected by Dorland, metastases were observed in the lungs of 78.38 per cent, in the vagina of 54 per cent, and in the kidney, spleen, and ovary of 13.5 per cent, in the liver, broad ligament, and pelvis respectively 10.8 per cent, and in the brain 5.4 per cent. The vaginal metastases are of particular significance, and occasionally are the only manifestation of the condition. In some cases, as reported by Hörmann and others, their excision may be followed by complete recovery.

Runge, in 1903, pointed out that lutein cystomata were sometimes observed in the ovaries. Upon analyzing 63 cases of chorionepithelioma in which the condition of the ovaries was described, he found such formations in 24 instances. Such findings still further emphasize the genetic relationship between the tumor and hydatidiform mole, and its implications were considered by Joseph and Raban in 1928.

In 1902, Wlassow and Schlagenhäufer made a contribution, which for a time threatened to overturn our ideas concerning the significance and mode of origin of chorionepitheliomata. They described generalized metastases following certain teratomata of the testicle, which were made up of syncytium, Langhans' cells, and even of structures resembling chorionic villi. Their observations have been abundantly confirmed by Risel, Teacher, Frank, and others; while Pick and others have reported similar conditions associated with ovarian teratomata.

In such cases, Schlagenhäufer assumed that portions of fœtal membranes had been included in the teratoma, and suddenly began to proliferate after lying dormant for years. Risel and all subsequent writers, on the other hand, hold that such an assumption is unnecessary, as they consider that the tumor may develop from undifferentiated fœtal ectoderm contained in the teratoma.

Clinical History.—Chorionepithelioma may occur at any age during the childbearing period, but according to Sunde it is relatively most frequent after the fortieth year. Except in the rare cases associated with teratomata, it always follows a pregnancy, no matter whether the latter is situated in the uterus, tube or ovary, or terminates in full-term labor, abortion, or hydatidiform mole, the last association being noted in nearly 50 per cent of the cases. The converse, however, does not hold good, as only 5 per cent of the 122 moles studied by Sunde were followed by the tumor.

Ordinarily there is no suspicion of the existence of the growth during pregnancy, or even during the first few weeks after delivery. In a small number of cases hemorrhage in the latter part of the puerperium may be the first indication of its existence, though this symptom is usually lacking. Occasionally a much longer period may elapse, and Krösing has collected 16 instances in which a period of latency, varying between one and nine years, was noted; while Sunde observed it in 5 of his 34 cases. Ries has given a satisfactory explanation for such an apparently contradictory development, as he was able to demonstrate the presence of chorionic villi in the uterus of an elderly woman eighteen years after the termination of her last pregnancy. In many instances the first indication is the appearance of vaginal or vulval metastases some weeks or months after the puerperium, though in Poten and Vassmer's case they appeared before the extrusion of the mole. The development of metastases in the lungs is usually associated with pulmonary symptoms, cough, and bloody expectoration. Occasionally, as reported by Hörmann and others, the growth may perforate the uterine wall and give rise to fatal intraperitoneal hemorrhage. Unless removed by operative procedures, the tumor rapidly causes death, the majority of patients succumbing within the first year. Indeed, it may be said that, in general, this is the most rapidly fatal malignant growth with which we are acquainted, though occasionally cases are encountered in which permanent cure follows a simple curettage.

Diagnosis.—If the existence of the growth is not indicated by the early occurrence of vaginal or vulval metastases, the diagnosis is not made until uterine hemorrhage, occurring at a varying period after the puerperium, indicates curettage, when the microscopic examination of the scrapings reveals characteristic changes.

The possibility of its development should be especially borne in mind whenever a woman has expelled a hydatidiform mole, in whom the subsequent appearance of a hemorrhage, or of other more obscure symptoms, should be an imperative indication for curettage and the microscopic examination of the scrapings. It should be constantly borne in mind that such a diagnosis is not always easy, and is of value only when made by one thoroughly conversant with the changes which may occur in the uterus following pregnancy. On one occasion at least, the failure to realize that fœtal cells may persist at the placental site for weeks after delivery led to the unnecessary sacrifice of the uterus.

Treatment.—If curettage reveals the existence of characteristic lesions in the uterus, immediate abdominal hysterectomy is imperative. On the other hand, when only vaginal metastases are present, the indications for radical operation are not so clear, as we know that the excision of the vaginal tumor may be followed by complete recovery. If, however, the uterus is also involved, hysterectomy as well as excision of the metastases is indicated, though the chances for ultimate recovery are slight. In such cases properly supervised radium treatment may be valuable.

Diffuse Myxoma of the Chorion.—Breslau and Eberth have called attention to a rare affection of the chorionic membrane, in which its connective-tissue layer undergoes myxomatous degeneration and becomes converted into a jelly-like substance analogous to the whartonian jelly of the cord. This layer may attain a thickness of 4 to 5 millimeters, but does not appear to exert any special influence upon pregnancy.

DISEASES OF THE AMNION

Hydramnios.—By hydramnios is understood the presence of an excessive quantity of liquor amnii. According to Lehn the normal amount of amniotic fluid is 1000 cubic centimeters in primiparæ and 1200 cubic centimeters in multiparæ, so that generally speaking, a quantity greater than 2 liters may be considered excessive.

Minor degrees of hydramnios—2 to 3 liters—are common, but the more marked grades are not frequent. In rare cases the uterus may contain an almost incredible amount of liquor amnii, Küstner having observed 15 liters, and Schneider 30 liters at the fifth and sixth months of pregnancy, respectively. In most cases the increase in the amount of amniotic fluid is quite gradual, but exceptionally it takes place very suddenly, so that the uterus may become immensely distended within a few days—*acute hydramnios*.

The fluid in hydramnios is usually identical in appearance and composition with that normally present in the amniotic cavity, although Prochownick states that the former occasionally contains a slightly increased amount of urea.

Etiology.—As was said when the physiology of the fœtus was dealt with, the amniotic fluid is normally derived from the fluids of the mother, which have been modified by the secretory action of the amniotic epithelium; while the fœtal kidneys take no part in its production, except under abnormal conditions. Polano, and Taussig think that its amount is regulated by the fœtus, and that anything which interferes with its swallowing leads to the accumulation of excessive quantities.

In general, it may be said that our knowledge concerning the mode of production of hydramnios is very defective, and that it is impossible to ascribe all cases to a single cause. Writers upon the subject state that the excess of amniotic fluid may be derived from several sources—from the amnion itself, from the fœtus, from the mother or from both fœtus and mother.

Forssell believed that he could demonstrate histological changes in the amniotic epithelium, which might explain the production of hydramnios, but other investigators, as well as I, failed to find that his observations were universally applicable. Others have attributed the condition to inflammatory changes in the amniotic membrane, but as these are of relatively common occurrence, the association must be regarded as accidental.

In a certain proportion of cases examination of the fœtus after death reveals the presence of some abnormality which may possibly bear a causal relation to the disease. Thus, hydramnios is sometimes, though not always, noted when the fœtus presents some abnormality or deformity, particularly anencephalus or spina bifida. Under such circumstances, it is believed that the superabundant fluid results from excessive urinary secretion, which is brought about by the stimulation of cerebral or spinal centers which have been deprived of their usual coverings, just as happens in the *piqûre* experiments of the physiologists; while others believe that it is due to the filtration of cerebrospinal fluid through the exposed meninges. Hydramnios is also found associated with other deformities, such as harelip, the various varieties of club-foot, ectopia of the bladder, etc., as well as certain tumors of the kidneys.

More frequently, however, the abnormality which is supposed to give rise to hydramnios is to be found in lesions which cause obstruction to the circulation either in the umbilical cord or within the fœtus. In other instances the condition is attributed to renal changes or to abnormalities in the cutaneous functions.

Sallinger has shown that an obstruction to the circulation in the umbilical vein is accompanied by an exudation of fluid from the external surface of the umbilical cord and from the fœtal surface of the placenta. This he attributed to the persistence of the so-called vasa propria of Jungbluth, which, springing from the fœtal end of the cord, lie between the chorion and amnion and usually become obliterated in the second half of pregnancy. Analogous observations have been made by Levison. According to Franqué, obliterative changes in coats of the arteries of the chorionic villi may lead to similar results. Leopold and Bar have shown that the obstruction may be due to stenosis or thrombosis of the umbilical vein, while Fehling has attributed it to torsion of the cord.

More frequently the obstruction lies within the fœtus. Thus, Opitz observed cirrhotic changes in the liver in all of his cases. Others have attributed it to syphilitic changes, though in my experience lues is an unimportant factor, as hydramnios does not occur more frequently in syphilitic than in normal children. In a small number of cases the obstruction to circulation is due to cardiac abnormalities. Thus, Woerz found the right auricle almost entirely occluded by a rhabdomyoma. Bar observed tricuspid insufficiency and stenotic changes about the pulmonary arteries; Lebedeff, aortic stenosis, and Nieberding, a narrowing of the ductus Botalli.

Many authorities believe that in a certain number of cases hydramnios is due to an excessive urinary secretion resulting from renal or cardiac lesions on the part of the fœtus. Opitz thought he had demonstrated that in hydramnios the liquor amnii contained a lymphagogue substance, which is normally absent. He considered that its presence in the tissues of the fœtus resulted in the extraction from the intervillous spaces of the placenta of a greater amount of fluid than usual. This necessitated increased exertion on the part of the heart, which eventually resulted in its hypertrophy. As a consequence a larger amount of fluid circulated through the kidneys, giving rise to an increased urinary secretion.

It is generally believed that the etiological importance of increased renal activity is strikingly illustrated in hydramnios occurring in single-ovum twins. Wilson (1899) analyzed the histories of 51 cases of hydramnios occurring in multiple pregnancy—46 twins and 4 triplets. Twenty-two of the twins were uniovular in origin, and, when one considers that these are four times less frequent than double-ovum twins, it is apparent that something connected with the former must exert an appreciable influence on the excessive production of amniotic fluid. In such cases, as a rule, the twins differ materially in size, and the hydramnios is limited to the amnion enclosing the larger child, while the other contains a normal or diminished amount of fluid. At autopsy the heart and kidneys of the fœtus accompanied by hydramnios are found to be both relatively and actually larger than those of the smaller twin. Werth, Strassman, Küstner, and Schatz in particular, have made extensive studies along similar lines, and all agree in attributing this difference to the presence in the single placenta of an area of circulation common to both twins, and believe that one twin, for some reason, receives a larger amount of blood than the other, this excess giving rise to cardiac hypertrophy which still further accentuates the condition, and in turn is followed by renal hypertrophy with increased secretion. Eventually the heart becomes unequal to its task and insufficiency results, which is followed by signs of obstruction, particularly in the liver, thereby completing a vicious circle.

Some authors consider that the skin plays a not unimportant part in the excessive formation of liquor amnii. Budin in one case was inclined to attribute it to a large nevus, through which he believed excessive exudation occurred. Furthermore, Wilson and others consider that excessive cutaneous activity is ofttimes associated with cardiac hypertrophy.

Occasionally diseases of the mother which are attended by circulatory disturbances, particularly cardiac and renal affections, or visceral syphilis, lead to edema of the placenta, with increased transudation into the amniotic cavity. The demonstration by Wolff that nephrectomy in pregnant rabbits was followed by increased renal activity on the part of the fœtus, with consequent hydramnios, also indicates the possibility of a similar occurrence in pregnant women suffering from serious renal disease. That hydramnios is not always dependent upon abnormalities of the fœtus is clearly shown in many specimens of abortion. In certain cases of "dropsical ovum," for example, the embryo has either entirely disappeared, or is represented only by a nodule of degenerated tissue, and yet the amniotic vesicle is distended by an amount of fluid far out of proportion to the duration of pregnancy. One or other of the conditions just mentioned may account for the excessive production of amniotic fluid in a considerable proportion of the cases; but they do not always afford a satisfactory explanation, inasmuch as in many instances careful search fails to reveal the presence of any condition which can be supposed to play a part in its production.

Taussig has pointed out that the placenta is frequently excessive in weight, and, although the child usually falls below the average standards, even if not actually deformed, it may sometimes weigh 4000 grams or more. He is, however, unable to correlate such variations with any etiological theory.

Symptoms.—The symptoms accompanying hydramnios arise from purely mechanical causes, and are due to the pressure exerted by the overdistended uterus upon adjacent organs. The effects are particularly marked in the respiratory functions, and, when the distention is excessive, the patient may suffer from severe dyspnea and cyanosis, and in extreme cases be able to breathe only in an upright position. Edema often occurs, especially in the lower extremities and about the vulva.

It is surprising what great degrees of abdominal distention can sometimes be borne by the patient with comparatively little discomfort, although this is the case only when the accumulation of fluid has taken place gradually. On the other hand, in acute hydramnios, a much slighter distention may lead to disturbances sufficiently serious to threaten the life of the patient.

Wieloch has demonstrated that the pressure symptoms are due entirely to the size of the uterus and not to any increase of pressure within it. Upon puncturing the uterus through the abdominal walls, and measuring the pressure by means of a lumbar puncture apparatus, he found that in hydramnios it was in no way increased over that obtaining in normal pregnancy, which is surprisingly low. For this reason, it appears improbable that the frequent occurrence of premature labor, which so frequently complicates the condition, can be ascribed to greatly increased intra-uterine pressure, and consequently it must be due to mere passive overdistention of the uterine walls by the abnormal size of the product of conception.

Diagnosis.—In moderate degrees of hydramnios palpation and percussion enable one to feel confident that the fluctuant tumor is the distended uterus, in which a readily ballottable fœtus can be felt, although its heart sounds are heard with difficulty.

The excessive enlargement of the abdomen due to multiple pregnancy occasionally renders the differentiation from hydramnios almost impossible; particularly as the latter is a frequent complication of the former condition. In such cases the hydramnios is usually detected, whereas the multiple pregnancy associated with it may pass unnoticed. On the other hand, in a multiple pregnancy not complicated by hydramnios, the diagnosis is comparatively easy, inasmuch as the large uterus is not fluctuant, while careful palpation will reveal the presence of several fœtal poles and an unusual number of small parts.

When the uterine distention is so excessive that the fœtus cannot be felt, the diagnosis of hydramnios becomes even more difficult, and many cases are recorded in which the condition was mistaken for a large ovarian cystoma, with the result that an unnecessary laparotomy was performed. Inquiry as to the possibility of pregnancy, careful examination, and the recognition of the fœtal skeleton in the x-ray plates, will generally serve to prevent such an error.

Excessive abdominal enlargement due to ascites can usually be differentiated by the characteristic changes in percussion. In rare instances pregnancy, complicated by a large ovarian cystoma, may be mistaken for hydramnios. In some cases the detection of two tumors—one corresponding to the uterus and the other to the cyst—will permit a correct diagnosis, but in others the condition may escape detection until after childbirth, or operation.

Treatment.—Minor grades of hydramnios rarely require active treatment. On the other hand, when the abdomen is immensely distended and respiration is seriously hampered, the termination of pregnancy is urgently indicated no matter to what period it may have advanced. In such cases interference is the more justifiable, since experience teaches that premature labor frequently occurs spontaneously if the patient is left alone, and that the child is often so poorly developed or so deformed that its chances of living are minimal. Vogt found that the fœtal mortality exceeded 50 per cent in 237 cases which he analyzed, and that 97 of the children were premature and 25 presented some malformation.

When necessary, the symptoms can be promptly relieved by perforating the membranes through the cervix, and labor pains set in after the amniotic fluid has drained off. In many instances the course of labor is greatly prolonged as a result of the loss of tonicity of the uterine musculature incident to excessive distention. In other cases it may be almost precipitate, and in this event there is an increased risk of atonic hemorrhage during and just after the completion of the third stage. For this reason the uterus should be carefully watched, and appropriate treatment instituted at the slightest sign of danger. Moreover, it should be remembered that abnormal presentations frequently result from the lack of accommodation incident to the excessive amount of amniotic fluid, so that operative interference will become imperative more frequently than under normal conditions.

Oligohydramnios.—In rare instances the amount of amniotic fluid may fall far below the normal limits, and occasionally be represented by only a few cubic centimeters of thick, viscid fluid.

The etiology is even less well understood than that of hydramnios. Jaggard, in 1894, reported a case in which the fœtus presented an imperforate urethra with absence of one and cystic degeneration of the other kidney, and he therefore concluded that the lack of amniotic fluid was the result of nonsecretion of urine. Since then numerous similar cases have been reported. On the other hand, abnormalities of the urinary tract cannot be regarded as the sole cause of the condition, as Hüssy and others have found that hydramnios may accompany such conditions. Forssell is inclined to attribute oligohydramnios to necrosis of the amniotic epithelium, which he believes favors undue absorption of the amniotic fluid. To what extent his observations hold, I am unable to say.

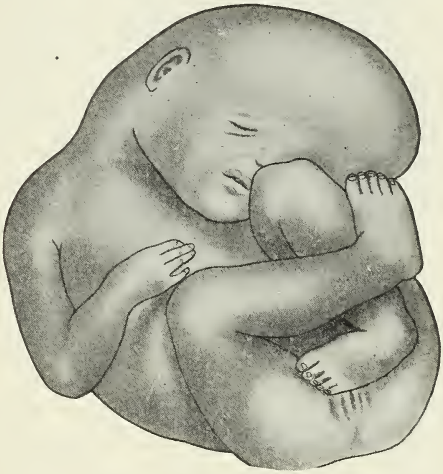


Fig. 516.—Compression of Fœtus in Oligohydramnios (Ahlfeld).

When oligohydramnios occurs early in pregnancy it is attended by serious consequences to the fœtus, as adhesions may be formed between its external surface and the amnion and give rise to serious deformities. When occurring later, its effect upon the fœtus, though less marked, is quite characteristic. Under such circumstances the latter is subjected to pressure from all sides and takes on a peculiar appearance, and many minor deformities, such as clubfoot, are frequently observed (Fig. 516).

In some cases of oligohydramnios the skin of the fœtus is markedly thickened, and presents a dry, leathery appearance. Most authorities attribute this to the lack of amniotic fluid, but Ahlfield is inclined to believe that it is the cause and not the result of the condition, since the skin lesion may be so marked as to interfere with the normal cutaneous functions and thus do away with one of the sources of the liquor amnii.

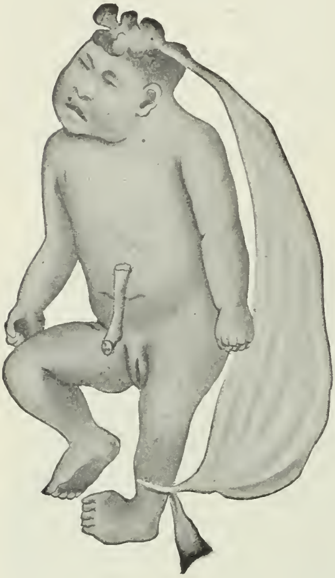


FIG. 517.—ENCEPHALOCELE RESULTING FROM AMNIOTIC ADHESIONS (Ahlfeld).

Amniotic Adhesions.—In oligohydramnios, and occasionally even when the liquor amnii is present in normal amounts, adhesions may form between the amnion and the surface of the fœtus. According to Simonart, Chaussier, in 1812, was the first to direct attention to this condition, and its consequences were further studied by Montgomery, G. Braun, Küstner, Ahlfeld, Chiari, and others.

The effects of amniotic adhesions are variable and depend in great measure upon their location. As a rule, when they develop early in pregnancy they give rise to serious deformities of the fœtus. The following abnormalities have been directly traced to the condition: Encephalocele or hemicephalus; fissure of the face, jaw, or lips; fissure of the thorax with ectopia cordis, and eventration with hernia of the umbilical cord.

In other instances, amniotic bands may encircle an extremity of the fœtus and so compress it as to lead to strangulation and subsequent spontaneous amputation. Figure 518 represents intra-uterine amputation of the fingers, and Figure 519 amputation of the arm, which I formerly thought were produced in this way. Braun has reported two cases in which the death of the fœtus was attributable to strangulation of the umbilical cord by such bands. Exceptionally, amniotic adhesions may give rise to dystocia, and Bardeleben and myself

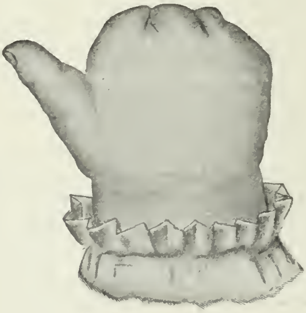


FIG. 518.—AMPUTATION OF FINGERS BY AMNIOTIC ADHESIONS (Küstner).

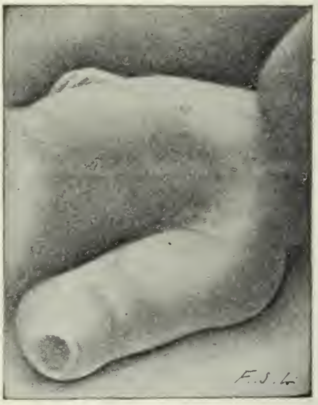


FIG. 519.—AMPUTATION OF ARM BY AMNIOTIC ADHESIONS.

have seen instances in which firm adhesions extending from the placenta to the abdomen of the child seriously interfered with its birth. Streeter, who has studied for years the mode of production of so-called intra-uterine amputation, believes that they never result from strangulation by amniotic bands, but are due to a trophic disturbance, somewhat suggestive of Reynaud's disease later in life. I have seen many of his specimens and am convinced that in general his interpretation is correct.

Inflammation of the Amnion.—Occasionally inflammatory processes implicate the amnion. These are usually associated with similar changes in the chorion and decidua, and result from preëxisting gonorrhea, from attempts at criminal abortion or from the extension of an intrapartum infection.

Cysts of the Amnion.—Now and again small cystic structures, lined by typical epithelium, may be formed in the amnion. They generally result from the fusion of amniotic folds with subsequent retention of fluid. Special attention has been devoted to this subject by Ahlfeld. The same observer has also described a dermoid cyst of the amnion, which does not, however, bear critical examination, inasmuch as the small particles found in it were probably mere concretions.

Amniotic Caruncles.—Under this name have been described certain nodules which occur upon the fœtal surface of the placenta, as well as upon the free amnion. Usually they appear in the neighborhood of the insertion of the cord as multiple, rounded or oval, opaque elevations, which vary from less than 1 to 5 or 6 millimeters in diameter.

Under the microscope they are seen to be made up of typical stratified epithelium. The lowest layer is cuboidal in shape and is continuous with the amniotic epithelium, while the upper layers become more and more flattened, and stain less and less well as the surface is approached. Such structures were found by my assistant, Solon B. Dodds, in 60 per cent of a large series of placentæ. As yet we are ignorant of their significance, although in the ruminants, in which they are very abundant and attain considerable proportions, they contain large quantities of glycogen.

ABNORMALITIES OF THE PLACENTA

Abnormalities in Size, Shape, and Weight.—The normal placenta is a flattened, roundish, or discoid organ, which averages from 15 to 20 centimeters in diameter, and from 1.5 to 3 centimeters in thickness. As compared with the fœtus, it is relatively larger in the earlier than in the later months of pregnancy, and varies considerably in size at term, though, generally speaking, the thickness is in inverse proportion to its area. Now and again, when inserted in the neighborhood of the internal os, the placenta may take on a horseshoelike appearance, its two branches running partially around the orifice. In very rare instances, as reported by Taurin, it may be a broad annular organ which encircles the uterine cavity just as the zonal placenta in carnivorous animals. In a case recorded by Fraenkel and Granzow, preëxisting endometritis was supposed to have played a part in its production.

The normal full-term placenta on an average weighs about one-sixth as much as the child, *i. e.,* somewhere in the neighborhood of 500 grams. Exceptionally it may be considerably heavier, Levy having reported a number of cases in which it exceeded 1000 grams in weight. In diseased conditions, on the other hand, this proportion no longer holds good, and in syphilis the placenta may weigh one-fourth, one-third, or even one-half as much as the fœtus. In albuminuria similar ratios obtain, which are due almost entirely to the imperfect development of the fœtus which characterizes such conditions. The largest placentæ with which we are familiar are observed in cases of general dropsy of the fœtus and placenta. In one of my cases of this character the fœtus and placenta weighed 1140 and 1200 grams, respectively, and in another the placenta weighed over 2000 grams. Cohen has reported a case in which the placenta weighed 2900 grams.

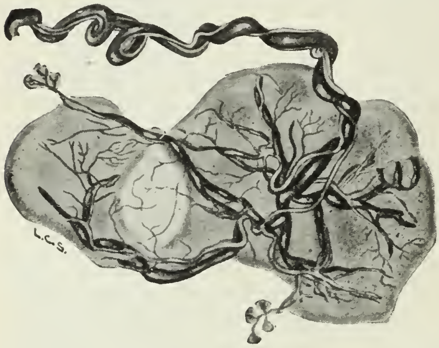


Fig. 520.—Placenta Fenestrata (Hyrtl).

Multiple Placenta in Single Pregnancies.—Occasionally in a single pregnancy the placenta is divided into several parts, which may be absolutely distinct, or more or less closely united. Such abnormalities have been studied more particularly by Hyrtl and Ribemont-Dessaignes, the latter stating that they occur about once in 352 cases.

In rare instances the placenta may be oblong in shape, with an aperture of varying size somewhere in the neighborhood of its center. To this abnormality Hyrtl applied the term *placenta fenestrata.* More frequently, the organ is more or less completely divided into two lobes. When the division is incomplete, and the vessels extend from one lobe to the other before uniting to form the umbilical cord, we speak of a *placenta dimidiata* or *bipartita* (see Fig. 521). According to Ahlfeld, this anomaly is noted about once in 600 cases. Again, the two lobes may be quite separate, the vessels being perfectly distinct and not uniting until just before entering the cord—*placenta duplex.* Occasionally the organ may be made up of three distinct lobes—*placenta triplex;*

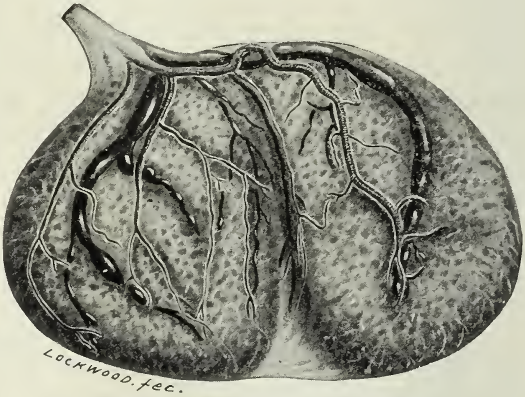


Fig. 521.—Placenta Bipartita.

while in very rare instances it may consist of a number of small lobes, Hyrtl having described as many as seven—*placenta septuplex.*

All of these conditions result from abnormalities in the blood supply of the decidua. Generally speaking, the portion of the ovum which is to become converted into the chorion frondosum, and later into the fœtal portion of the placenta, is that which is in contact with the most highly vascularized portion of the decidua. If the vascularization, instead of being practically limited to a single area, develops in several separate portions of the decidua, some such anomaly is bound to occur. Küstner believes that certain cases of placenta bipartita or duplex owe their origin to extensive infarct formation by which the intervening tissue is destroyed; but such an explanation cannot be accepted when the several lobules are separated from one another by apparently normal membranes.

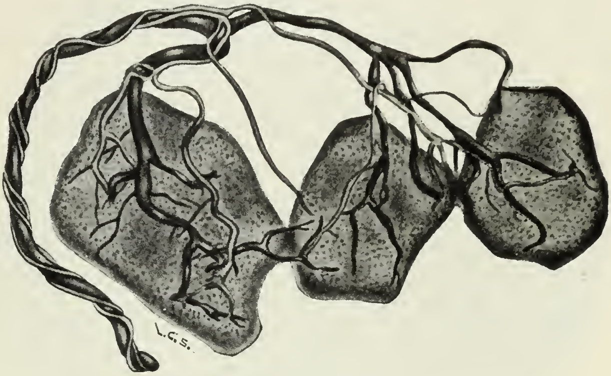


Fig. 522.—Placenta Tripartita (Hyrtl).

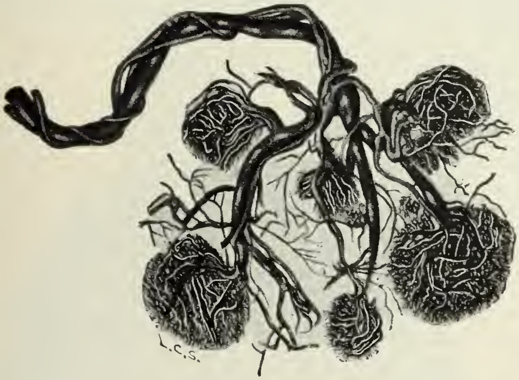


Fig. 523.—Corrosion Preparation of Placenta Septuplex (Hyrtl).

Placenta Succenturiata.—An important, and not infrequent, anomaly is the so-called *placenta succenturiata,* in which one or more small accessory lobules are developed in the membranes at some distance from the periphery of the main placenta. Ordinarily they are united to the latter by vascular connections. Occasionally, however, these are lacking, and as a result we have what are known as *placentæ spuriæ.*

The placenta succenturiata is of considerable clinical importance, because the accessory lobules are sometimes retained in the uterus after the expulsion of the main placenta, and may give rise to serious hemorrhage. For this reason, one should always bear in mind the possibility of their existence, and, in examining the after-birth, the membranes should be inspected, as well as the placenta. Should small, roundish defects be present a short distance from the placental margin, the retention of a succenturiate lobe should be suspected, and this becomes a certainty if vessels extend from the placenta to the margins of the tear. In such cases, even if no hemorrhage occurs, the hand should be introduced into the uterus for the purpose of locating and removing the offending structure.

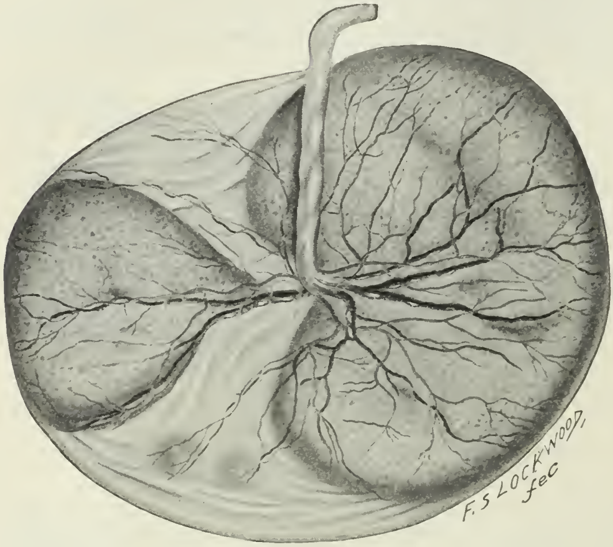


Fig. 524.—Placenta Duplex, with Two Succenturiate Lobules. × ½.

Placenta Membranacea.—In rare instances the decidua capsularis is so abundantly supplied with blood that the chorion læve in contact with it fails to undergo atrophy. In such circumstances, the entire periphery of the ovum is covered by functioning villi, so that the placenta, instead of being a discoidal organ limited to the decidua basalis, is a thin membranous structure occupying the entire periphery of the chorion—*placenta membranacea.* This abnormality does not interfere with the nutrition of the ovum, but occasionally gives rise to serious complications during the third stage of labor, since the thinned-out placenta does not readily separate from its area of attachment and causes profuse hemorrhage. This necessitates manual removal, which is sometimes very difficult.

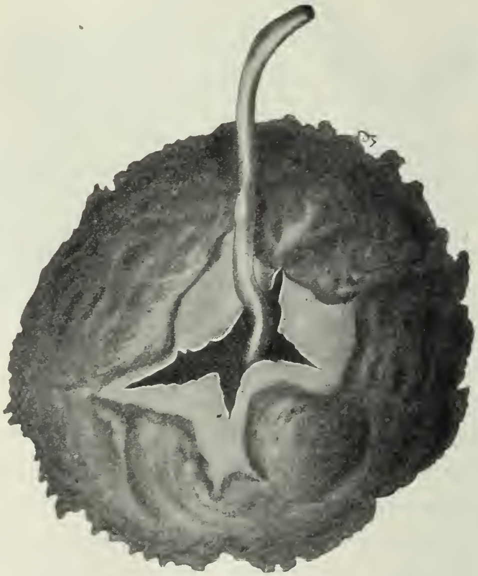


Fig. 525.—Placenta Membranacea (von Weiss).

Placenta Circumvallata.—In exceptional instances, the fœtal surface of the placenta may present a central depression surrounded by a thickened, whitish ring, which is situated at a varying distance from the margin of the organ—annulus fibrosus. According as the ring is complete or incomplete, we have to do with a complete or incomplete circumvallate placenta. When the ring coincides with the placental margin, the condition is sometimes described as placenta marginata. Within the ring, the fœtal surface presents the usual appearance, gives attachment to the umbilical cord, and shows the usual large vessels. These, however, instead of coursing over the entire fœtal surface, terminate abruptly at the margin of the ring. The ring itself is composed of a double layer of amnion and chorionic membrane, which has undergone infarction; while the surface of the placenta outside of it is covered by a layer of decidua, which in turn is covered by the deflected membranes on their way to line the interior of the uterine cavity. Figure 527 gives a good idea of these relations, and those interested in further details are referred to my article of 1927.

Placenta circumvallata appears to be due to the fact that a smaller part than usual of the periphery of the early ovum becomes converted into the chorion frondosum, with the result that the chorionic plate of the placenta is so small that further growth of the organ can be effected only by the proliferating villi invading the surrounding decidua. As the resulting extra-chorionic, or subdecidual, portion of the placenta develops, it becomes covered by the fœtal membranes after they have become folded at the margins of the chorionic plate. Various writers hold the condition responsible for all kinds of clinical manifestations, but in my experience it has no effect upon the course of pregnancy or labor, and consequently it should be regarded solely as an interesting abnormality, whose mode of production could not be explained satisfactorily until our ideas concerning the development and growth of the placenta had attained a certain degree of finality.

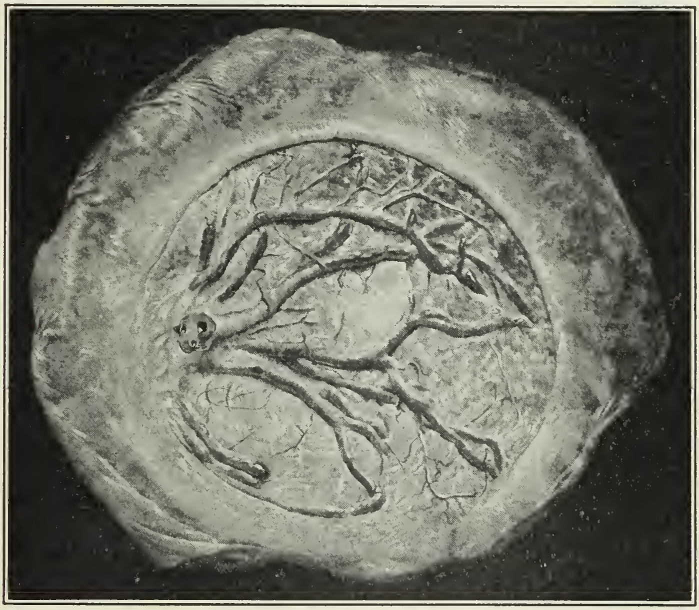


FIG. 526.—PLACENTA CIRCUMVALLATA. × ½.

Placenta Prævia.—Once in several hundred cases the placenta, instead of being inserted upon the anterior or posterior wall or the fundus of the uterus, is implanted upon the lower uterine segment in such a manner as to overlap more or less completely the internal os—*placenta prævia.* As this condition is unavoidably associated with hemorrhage during the first stage of labor, and is a most serious complication, it will be dealt with in a separate chapter.

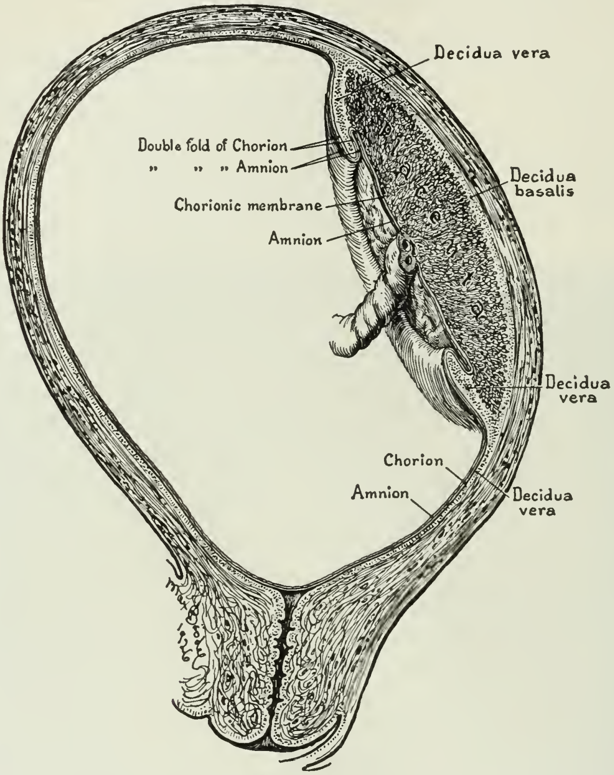

Decidua vera
Double fold of Chorion
" " " Amnion
Decidua basalis
Chorionic membrane
Amnion
Decidua vera
Chorion
Amnion
Decidua vera

Fig. 527.—Diagram Showing Circumvallate Placenta in Situ.
Note relations of chorionic membrane, extrachorionic decidua and duplication of membranes.

DISEASES OF THE PLACENTA

Infarct Formation.—The most frequent abnormality of the placenta consists in the development of certain degenerative changes, which have been variously designated as placentitis, schirrus, atrophy, hepatization, apoplexy, phthisis, necrosis, fatty and fibrofatty degeneration of the placenta, etc., but which are now generally described as *placental infarcts.*

These structures vary materially in size, shape, and appearance, and are best described under the following headings:

1. Flattish, whitish or yellowish fibrous placques on the fœtal aspect of the placenta. These vary in size from a few millimeters in diameter to large structures involving a considerable fraction of the chorionic membrane. They are rarely more than a few millimeters in thickness and are closely attached to the outer or maternal surface of the chorionic membrane. Very exceptionally they may involve the entire fœtal surface of the placenta and form a thick layer beneath it. These are designated as subchorionic infarcts.

2. A whitish or yellowish rim of opaque material may extend for a varying distance around the margin of the placenta, and may involve everything included between its fœtal and maternal surfaces. Occasionally it forms a complete ring —marginal infarct.

3. Wedge-shaped or irregular round areas of varying size, which usually extend from the maternal surface into the substance of the placenta. These are dull white in color, exhibit a striated or fibrous structure, and are sharply differentiated from the surrounding normal tissue. These are designated as white infarcts, and, as will be stated below, may be of varying origin. Usually, they do not exceed a centimeter or so in diameter, but occasionally they attain large dimensions and involve one or more cotyledons, while exceptionally a large portion of the organ may be involved, one-half and sometimes nearly its entire substance being implicated.

4. Small hemorrhagic areas situated in any part of the placenta. These rarely exceed one or two centimeters in diameter, slowly undergo coagulation, and eventually become converted into dull white striated structures almost identical with those described under (3). In order to differentiate them from the other types, I have tentatively designated them as "laminated clots."

5. Pinkish or brickdust-colored, irregularly shaped, more or less solid masses, sharply marked off from the surrounding tissue, may occupy a larger or smaller portion of the placenta. They are usually more prominent on the maternal surface, and frequently extend through the entire thickness of the placenta; they are sometimes termed *red infarcts.*

6. Somewhat more frequently, roundish areas varying from bright red to almost black in color, and measuring from one to three centimeters in diameter, are scattered through the substance of the placenta. They are composed almost entirely of blood, and are sharply differentiated from the surrounding tissue by a capsule which presents a whitish and fibrous appearance. When they occur in considerable numbers, the entire placenta is studded with them, presents a nodular surface, and on section an appearance which Pinard has aptly described as *placenta truffé.*

These structures are also designated as red infarcts, though many authors prefer to speak of apoplexy or hematoma of the placenta. They differ markedly in structure and appearance from the other form of so-called red infarcts, and probably have nothing in common with them.

Frequency.—Minute subchorionic, marginal or white infarcts are present in every placenta, while I found similar areas, measuring 1 centimeter or more in diameter, in 63 per cent of 500 consecutive placentæ. If not present in excessive numbers, such infarcts possess no clinical significance, and according to the researches of Eden and myself are to be regarded as signs of senility of the organ. On the other hand, when they are of large size and abundant, they may mechanically throw out of function so great a portion of the placenta as seriously to interfere with the nutrition of the fœtus, and sometimes cause its death.

Mode of Formation.—Unfortunately, it is impossible to explain satisfactorily the mode of formation and origin of placental infarcts, for the reason that various conditions which have little in common are grouped together under that designation. Furthermore, our knowledge concerning certain types is so imperfect that positive statements are not justified. In general, Grosser has stated the facts with care and accuracy, while the long-winded descriptions of Hinselmann only serve to confuse the student. Full literature upon the subject up to 1926 will be found in the article of Siddall and Hartman.

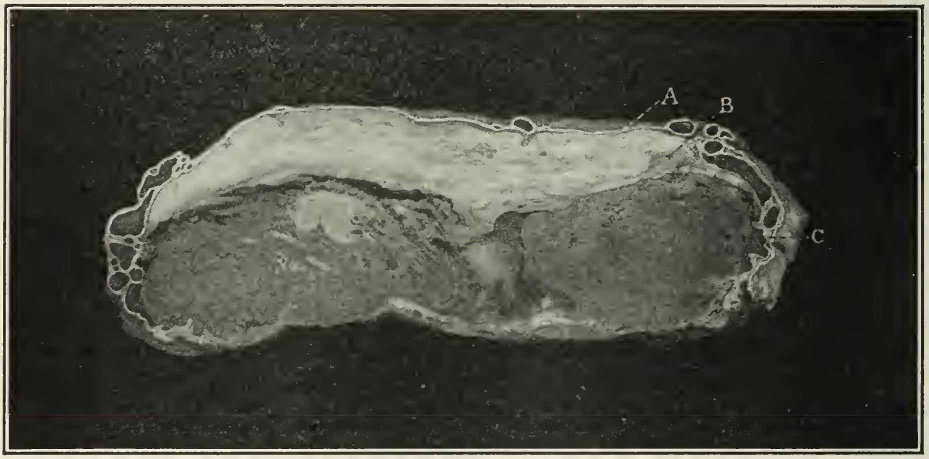


Fig. 528.—Subchorionic Infarct of Placenta. × ⅔.
A, amnion and chorionic membrane; *B*, fibrinoid; *C*, unchanged placental tissue.
(In this instance the infarct was unusually extensive and led to the death of the fœtus.)

The origin of the subchorionic and marginal types (1 and 2) is reasonably clear. In both, stasis and coagulation of maternal blood occurs in portions of the placenta in which the intervillous circulation is normally sluggish. Following coagulation, fibrin is formed and slowly increases in amount. As it does so, it encircles chorionic villi and trophoblastic septa, interferes with their nutrition and eventually leads to their degeneration and ultimate conversion into fibrinoid. In the early stages of the process unusual proliferation of chorionic epithelium occurs, which is followed by degenerative changes, with the result that a thicker or thinner mass of fibrin or fibrinoid results, in which it is impossible to determine what part has been derived from coagulated maternal blood and what from fœtal tissues which have undergone secondary degeneration. Such infarctions

PLATE XIV.

Fig. 1.

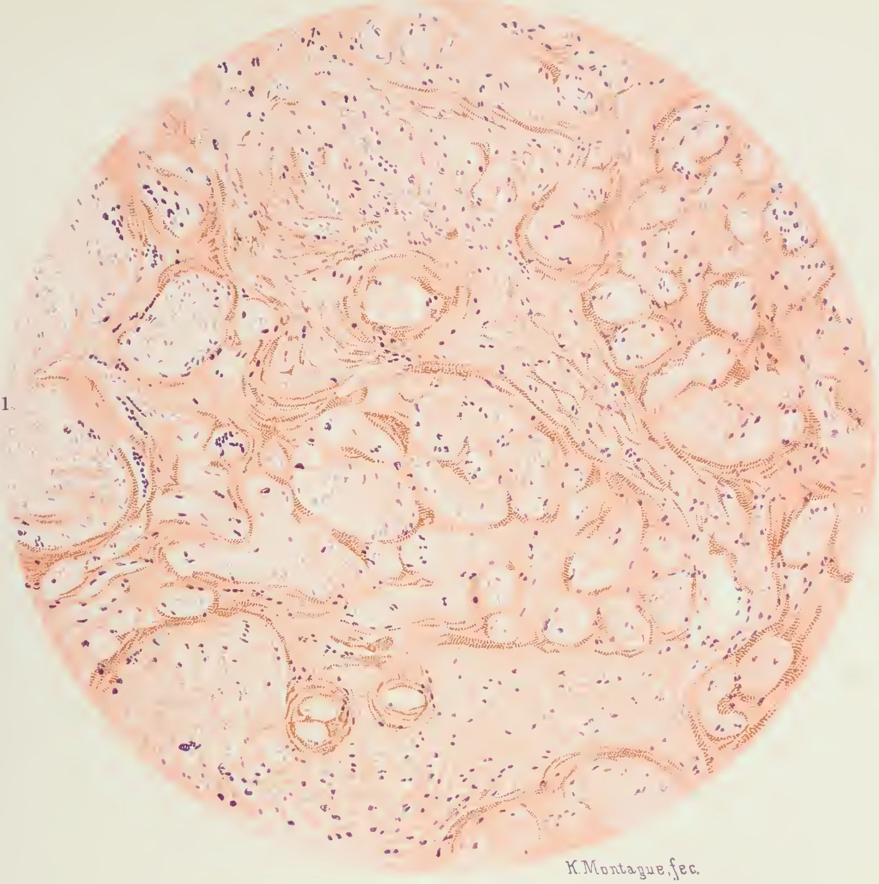
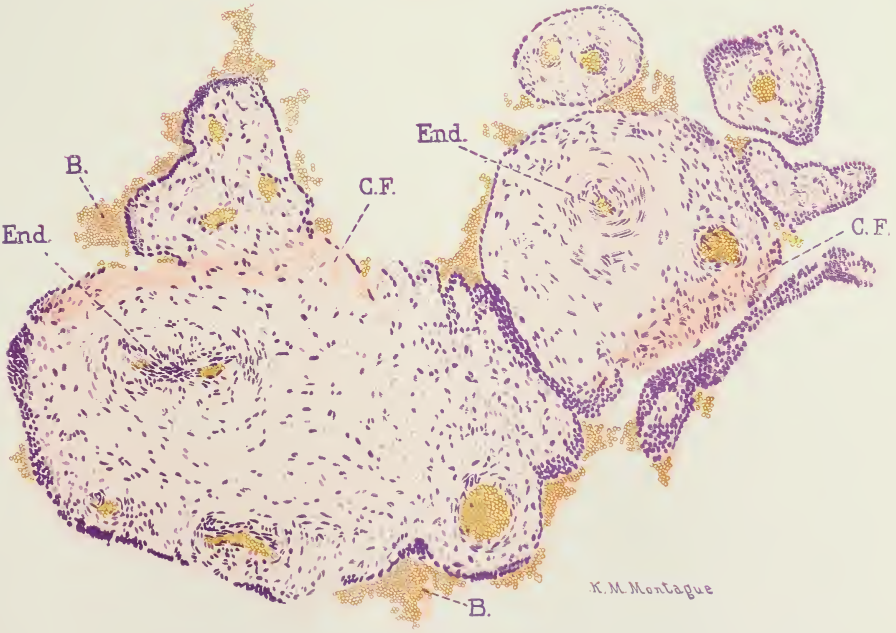

K.Montague,fec.

Fig 2.


B.
End.
C.F.
End.
C.F.
K.M.Montague
B.

PLACENTAL INFARCT FORMATION. × 60.

Fig. 1.—Fully developed infarct.

Fig. 2.—Chorionic villi, showing endarteritis and formation of canalized fibrin. *B.*, blood in intervillous spaces; *C. F.*, canalized fibrin; *End.*, arteries showing obliterating endarteritis.

do no harm unless they become so extensive as to interfere with the circulation in the uninvolved parts of the placenta.

When we come to consider the origin of the structures grouped under 3 and 4, the problem becomes more complicated, as the so-called white infarct may result from at least three fundamentally different processes. The researches of Ackermann, Orth, Eden, Kermauner, and myself, indicate that in some cases white infarct formation is the result of obliterating endarteritis in the vessels of the chorionic villi, and is brought about in the following manner: As soon as the circulation through the arteries of the chorionic villi is interfered with by the endarteritic process, necrotic changes begin to appear at their periphery (Plate XIV, Fig. 2). Owing to the fact that the syncytium is nourished in part by the maternal blood, the changes occur first in the layer of tissue just beneath it, and manifest themselves as coagulation necrosis of the tissue which has replaced Langhans' layer of cells. As the process becomes more marked, this is gradually converted into the so-called canalized fibrin or fibrinoid. A little later the syncytium undergoes a similar change, the fibrin then coming in direct contact with the maternal blood in the intervillous spaces. As a consequence, the blood immediately adjoining the necrotic tissue coagulates with eventual fibrin formation.

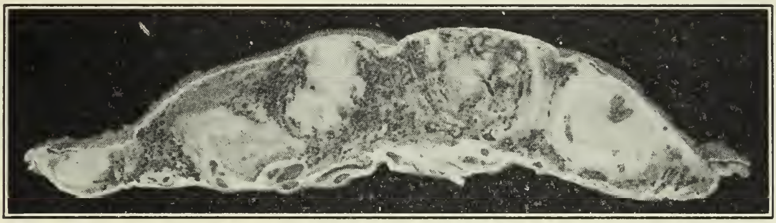


FIG. 529.—SECTION OF PLACENTA SHOWING LARGE WHITE INFARCTS. × ⅔.

When similar changes occur in several adjacent villi, the maternal blood lying between them undergoes coagulation, so that eventually a number of villi become fused together by fibrin. A little later the stroma of the implicated villi undergoes coagulation necrosis, and finally the conversion into fibrin becomes so extensive that large areas are produced in which only the shadows of degenerated villi can be distinguished (Plate XIV, Fig. 1). Ultimately the outlines of the villi disappear, and the entire mass takes on a homogeneous fibrinous appearance, in which it is impossible to distinguish the component parts. For full particulars concerning the process, the reader is referred to my monograph upon the subject.

Equally frequently another type of white infarct is observed, which, for ease in differentiation, I designate as atypical, and which differs from that just described by the relative absence of fibrin and of changes in the villous vessels. In this variety the villi, whose vessels are distended with blood, are closely packed together, and there is little or no development of fibrin between them. The syncytium remains intact for a long time, while the stroma soon presents a necrotic appearance; finally the syncytium becomes implicated and a fibrous mass results in which the pale outlines of villi are long distinguishable. When the atypical infarct is in contact with the decidua basalis, extensive necrotic changes are noted in the latter, which makes it possible that Young and Clemenz are correct in attributing such infarcts to the occlusion of maternal vessels supplying isolated areas of the placenta.

Even more frequently, the mode of origin described by Dieckmann and McNalley comes into play. These writers have described the occurrence of isolated collections of blood in the intervillous spaces, which in the fresh state appear as small reddish areas of fresh blood, usually 1 to 1.5 centimeters in diameter, but never exceeding 2.5 centimeters. In a short time the blood clots, and eventually becomes converted into fibrin. The clot is at first surrounded by normal villi, but proliferative changes followed by degeneration soon appear in their epithelium, and eventually a capsule develops which is made up of degenerated and fused villi.

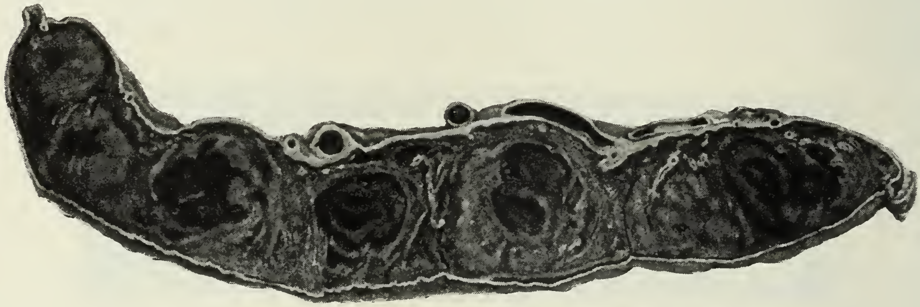


FIG. 530.—SECTION OF PLACENTA SHOWING MULTIPLE RED INFARCTS (placenta truffé). × ⅔.

Eventually, each of these three types of infarct is represented by a mass of striated fibrin or fibrinoid, surrounded by a capsule of degenerated villi. The x-ray pictures taken by Thoms of injected placentæ presenting such abnormalities show a surprising diminution in the number of smaller fœtal vessels. Furthermore, the situation is still further complicated by the fact that similar changes may result from the degeneration of the chorionic cells making up trophoblastic septa, as well as of the decidua basalis—with the result that it is impossible in the mature infarct to recognize the tissue from which it originated.

Red infarcts of the placenta are less frequently observed. The type described in section 6 is sometimes associated with chronic nephritis, as well as with premature separation of the placenta, and was noted in 33, 60 and 66 per cent of the nephritic cases studied by Cagny, Rossier, and Martin, respectively. In all instances, the tissue surrounding the collection of blood is compressed, and is usually made up of fused and degenerated villi. It is not clear whether the blood is of fœtal or maternal origin; but, in some of the cases associated with premature separation of the placenta, the blood in the interior of the red infarct is continuous with that of the subplacental, decidual hematoma.

The mode of production of these interesting formations is in urgent need of elucidation, but, until it is forthcoming, I must confess my ignorance, and can make only one positive statement concerning them, and that is that they are rarely observed in the placentæ of eclamptic women.

Cysts of the Placenta.—Cystic structures are frequently observed upon the fœtal surface and occasionally in the depths of the placenta. Small cysts a few millimeters in diameter were noted in 56 per cent of the placentæ studied by Kermauner. Larger ones, occasionally attaining the size of a lemon, are observed but rarely. In one of my specimens, five cysts varying from 3 to 5 centimeters in diameter, projected from the fœtal surface of the placenta.

Such cysts are derived from the chorionic membrane, as is shown by the fact that the amnion can be readily stripped off from them. Their contents are usually clear and transparent, but are sometimes bloody or grumous. The walls, especially the portions adjacent to the intervillous spaces, are lined in great part by a dull whitish membrane, while occasionally a portion is occupied by a white infarct.

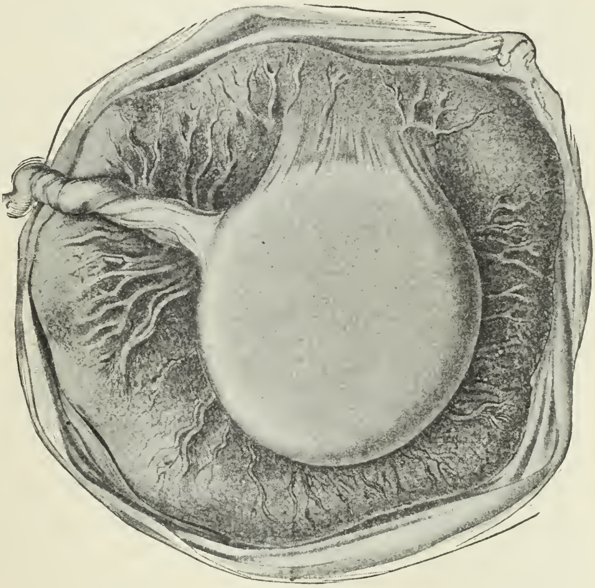


FIG. 531.—CYST OF PLACENTA (Ehrendorfer). × ½.

On microscopic examination, the lining membrane is found to be made up of one or more layers of tolerably large epithelial cells with round vesicular nuclei, which frequently present various degrees of degeneration. Here and there, corresponding to the situation of a white infarct, the cells are absent and the wall consists of fibrin. The researches of Ehrendorfer, De Jong, Vassmer, and Schickele have clearly shown that the cells in question are trophoblastic in origin, and that the cysts result from their degeneration.

The cysts occurring in the depths of the placenta rarely exceed 1 centimeter in diameter. They frequently occupy the center of an infarct, are filled with grumous contents, and were mistaken by the older writers for abscesses. In other cases the contents are clear, and in this event the walls of the cyst are lined by cells identical with those composing the trophoblastic or "decidual" septa of the placenta, and the fluid contents are clearly derived from their degeneration. Full literature upon the subject up to 1927 will be found in the article of Paddock and Greer.

So far as present experience goes, cystic formations, whether occurring upon the fœtal surface or in the depths of the placenta, are of interest purely from a pathological point of view, and exert little or no influence upon the course of pregnancy or labor.

Tumors of the Placenta.—John Clarke, in 1798, described a solid tumor about the size of a man's fist, which made up a large part of the placenta. In recent years a number of tumors, varying in size from that of a pea to that of a man's fist, have been described. Siddall, was able to collect 130 cases from the literature up to 1924, and stated that the largest tumor reported weighed 740 grams. In my experience, careful routine examination shows that such tumors, from the size of a small pea upward, occur about once in every 100 placentæ.

According to Virchow, the most frequent variety of placental tumor is the myxoma fibrosum, which is composed in great part of fibrous tissue having abundant oval nuclei, with typical myxomatous areas scattered through it, but in my experience the so-called angiochorioma is much more frequent. Until recently the placental tumors have been variously designated, and the 36 examples collected by Albert were classified as follows:

Myxoma fibrosum	14
Fibroma	10
Angioma	9
Sarcoma	2
Hyperplasia of chorionic villi	1

The work of all recent investigators, which has been well summarized by Siddall and with which I agree, shows that they are practically all of one type, and consist of masses of chronic villi with immense hypertrophy and hyperplasia of the terminal vessels, so that they may be designated as angiochoriomata. Dienst suggested that they be designated as chorioma angiomatosum, or fibrosum, according as dilated vessels or connective tissue predominate. In many instances the tumor is connected with the chorionic membrane by a small pedicle, in which an artery and vein can usually be distinguished. Various theories have been advanced as to their mode of origin, but none of them appears to be satisfactory. In my experience, the change originates in an unusual proliferation of vessels in villi of normal dimensions. This is followed by a considerable increase in size, so that the enlarged villi come into contact and eventually fuse, giving rise to the giant villi, which make up the tumor.

As the chorio-angiomata do not affect the surrounding placental tissue, they do no harm unless they involve so considerable an area as to throw a large part of the placenta out of function. Siddall, from a study of the reported cases, believes that when the tumor attains any considerable size it is frequently associated with hydramnios, and that the relatively high fœtal mortality is due to the premature termination of pregnancy so frequently incident to that condition. On the other hand, no such association was noted in any of the 30 to 40 cases which I have studied. As a curiosity, Emge's case may be mentioned, in which a pedunculated hemangiomatous tumor offered mechanical obstacle to the descent of the head, which could not be delivered until the tumor had been pushed up above it.

In this connection, I might mention a specimen which Cary, of Brooklyn, was kind enough to send me. In it the stroma of the large tumor was so rich in cells that I was tempted to designate it as a sarcoma of the placenta, under which name it has passed into the literature. I now feel that the diagnosis was incorrect, and that the tumor differed from the relatively common angiochorioma only in the relative absence of blood vessels.

Walz, in 1906, described a number of multiple tumors in the placenta presenting a structure typical of myxosarcoma. These he considered were metastases from a similar tumor in the leg, which had originated during pregnancy. Senge a few years later described a carcinomatous growth in the placenta, which he regarded as a metastasis from a carcinoma of the stomach, and Hinselmann states that three other similar cases have been recorded. These observations are of great interest, in that they forcibly illustrate the connection of the intervillous spaces with the general maternal circulation.

Inflammation of the Placenta.—Under the term *placentitis* many of the older writers described changes which we now recognize as infarct formation. Moreover, as has already been said, small placental cysts filled with grumous contents were formerly thought to be abscesses. Hence it follows that most of the statements in the abundant early literature upon inflammatory lesions of the placenta must be received with the greatest caution. At the same time acute inflammation of the placenta is occasionally met with. It is not a primary condition, but is usually due to the extension of a similar process from the decidua, resulting from an exacerbation of a preëxisting chronic gonorrhea, or from an acute infection due to pyogenic bacteria. Very exceptionally, abscess formation may be a manifestation of a general infection originating in any portion of the body.

In cases of prolonged labor, as will be elaborated in Chapter XXXI, Slemons has shown as the result of intrapartum infection that pyogenic bacteria may invade the fœtal surface of the placenta, and, after gaining access to the chorionic vessels, give rise to general infection of the fœtus.

Frequently, upon examining sections of placental tissue under the microscope, I have found the decidua basalis infiltrated with leukocytes and presenting the characteristic picture of an acute inflammation, while the adjacent intervillous spaces are crowded with leukocytes. Franqué observed similar conditions, but is inclined to believe that in most instances the implication of the placenta is secondary to the death of the fœtus.

Tuberculosis of the Placenta.—Tubercle formation in the fœtal portion of the placenta is extremely infrequent. For particulars the reader is referred to the chapters upon the Physiology of the Fœtus and upon the Infectious Diseases Complicating Pregnancy.

Calcification of the Placenta.—Small calcareous nodules, sometimes occurring in the form of flat plaques, are frequently observed upon the maternal surface of the placenta, and are occasionally so abundant as to give to the finger the same sensation as when feeling a piece of coarse sandpaper. Schönig showed that the chalky material was usually deposited in the necrotic tissue surrounding the ends of the "fastening" villi, as well as in the superficial layers of the decidua basalis.

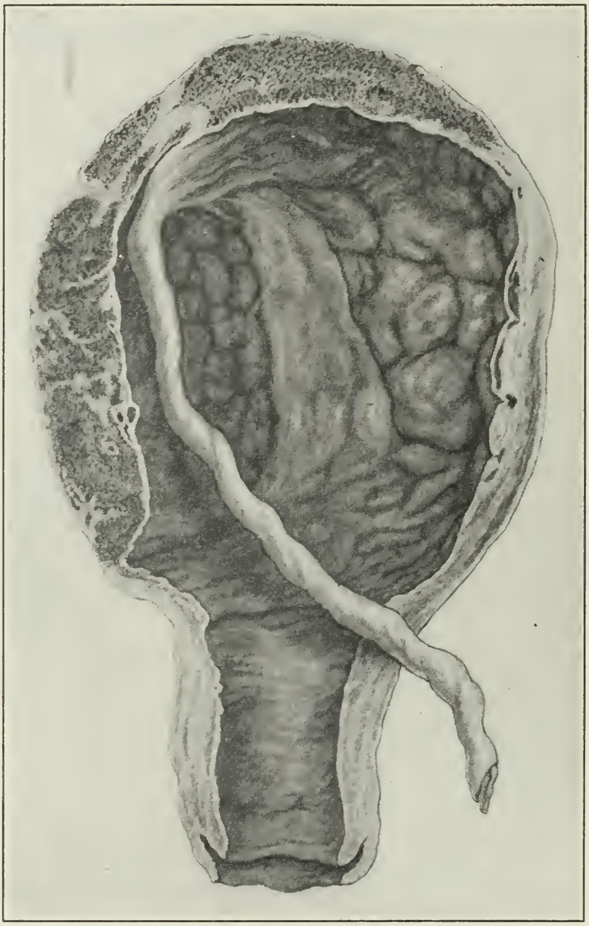


Fig. 532.—Placenta Accreta (Dietrich).
Note that the placenta has invaded more than one half of the uterine muscle.

When the widely spread occurrence of degenerative changes in the placenta is remembered, it should be a matter of surprise, not that calcification is occasionally met with, but rather that it is not noted in almost every placenta, inasmuch as apparently ideal conditions for its formation are constantly present in the later months of pregnancy.

Abnormal Adherence of the Placenta.—*Placenta Accreta.*—In the vast majority of cases the term *adherent* placenta is a misnomer, since the interference with its expulsion is usually due to abnormalities in the uterine contractions rather than to abnormal adhesions between it and the uterine wall. In rare instances, on the other hand, as the result of imperfect development of the decidua, or of excessive proliferative properties of the chorionic epithelium, the villi may invade the underlying muscularis, and in extreme cases, as shown in Figure 532, reach the peritoneal surface of the uterus. In other words, we have to deal with placenta accreta.

In such circumstances, spontaneous extrusion of the placenta cannot occur, and even its manual removal cannot be effected, with the result that death from hemorrhage usually occurs unless radical cesarean section is promptly done. Klaften has described a case of his own, and collected 45 others from the literature, with a mortality of 87.5 per cent in those treated conservatively, as compared with 14.3 per cent in those treated radically.

ABNORMALITIES OF THE UMBILICAL CORD

Variations in Insertion.—The umbilical cord is usually inserted eccentrically upon the fœtal surface of the placenta, somewhere between its center and periphery. A central insertion is less common, while in a still smaller number of cases the junction has taken place near the margin, giving rise to a condition known as *battledore placenta.*

In a series of 2000 placentæ, which I studied in this regard, the insertion was eccentric in 73 per cent, central in 18 per cent, and marginal in 7 per cent. These variations possess no clinical significance.

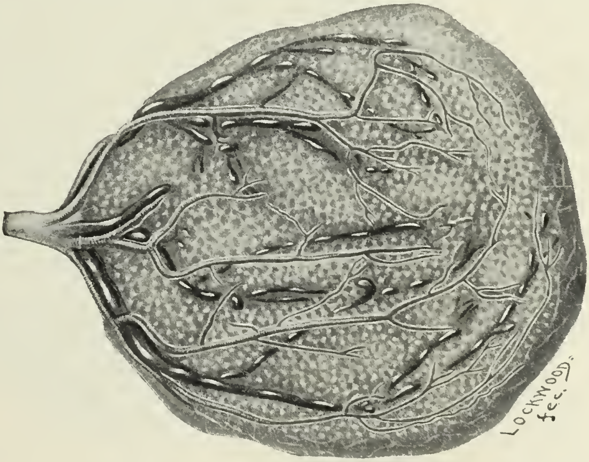


Fig. 533.—Marginal Insertion of the Cord. Battledore Placenta.

On the other hand, the so-called *velamentous insertion of the cord*—insertio velamentosa—is of considerable practical importance. In this condition the vessels of the cord separate some distance from the placental margin and make their way to the latter in a fold of amnion. This mode of insertion was noted in 0.84 per cent of 15,891 placentæ examined by Lefèvre, and in 1.25 per cent of our cases. According to

Mironoff it occurs nine times more frequently in twin than in single pregnancies, being noted in 5 and 0.57 per cent of the cases, respectively.

Its mode of production has given rise to a great deal of speculation. So long as the old views were in vogue concerning the part played by the allantois and the amnion in the formation of the umbilical cord, Schultze's explanation obtained almost universal acceptance. According to this, the anomaly was the result of abnormal adhesions between the umbilical vesicle and the chorionic membrane, whereby the amnion was prevented from applying itself in the usual manner to the cord. At present, however, this explanation is not regarded as

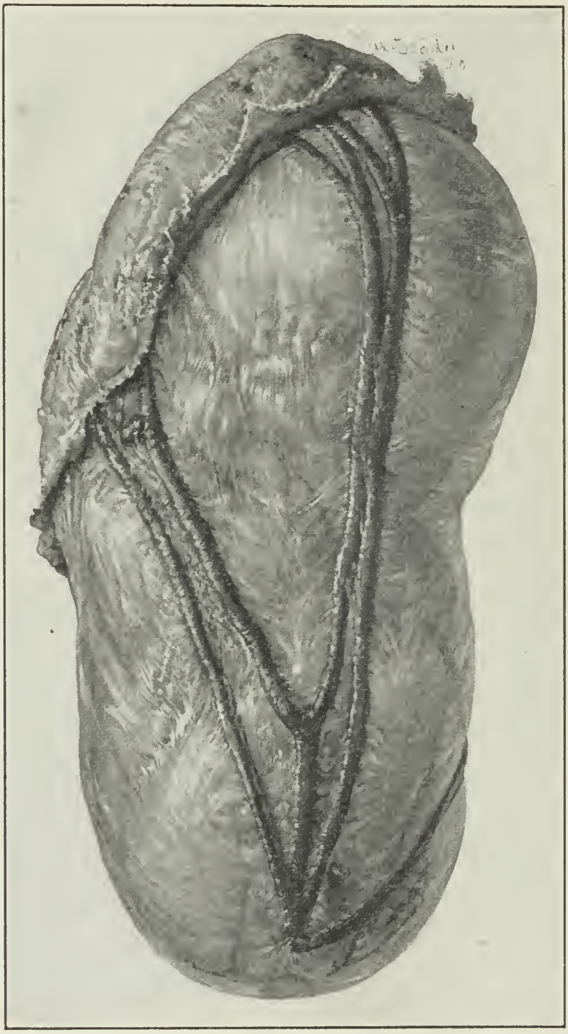


Fig. 534.—Vasa Prævia with Breech Presentation. × ⅓.
Note that cord arises from lowermost portion of fœtal membranes.

satisfactory, as it is now recognized that the allantois plays an insignificant part in the formation of the cord in human beings.

According to Franqué, the abdominal pedicle ordinarily extends to the fœtus from that portion of the chorion which is in contact with the most richly vascularized portion of the decidua—usually the decidua basalis—so that the cord becomes inserted upon the placenta. Occasionally, however, during the first few days of pregnancy, the area of greatest vascularization may be in the decidua capsularis, and in such circumstances the abdominal pedicle takes its origin from that location. With the advance of pregnancy, however, the area of vascularization eventually shifts to the decidua basalis—the site of the future placenta—while the abdominal pedicle retains its original position, and from its maternal end the vessels extend to the placental margin. The correctness of this explanation was endorsed by Ottow, in 1922.

When the placenta is inserted low down in the uterus, the velamentous vessels may extend partially across the internal os—*vasa prævia*—and as dilatation progresses be pressed upon by the presenting part, the interference with the circulation causing asphyxia of the fœtus. In rare cases such vessels are torn through when the membranes rupture, and the fœtus bleeds to death. The full literature upon this subject up to 1898 has been collected by Peiser.

Figure 534 represents an unusual case of vasa prævia. In this instance the umbilical cord arose from the most dependent portion of the membranes, instead of from the fœtal surface of the placenta. Rupture of the membranes, and escape of the child, occurred in the "V"-shaped space between the vessels at the lower right side of the specimen, but did not involve them.

Variations in Length of Cord.—Normally, the umbilical cord averages about 55 centimeters in length, though it may present marked variations—0.5 to 198 centimeters (Dyhrenfurth and Hyrtl). In rare instances it may be so short that the abdomen of the fœtus is in contact with the placenta, but under such circumstances a congenital umbilical hernia is always present.

According to Kaltenbach the cord must be of a certain length in order to permit of delivery of the child—that is, it must be sufficiently long to reach from its placental insertion to the vulva, 35 centimeters when the placenta is inserted high up, and 20 centimeters when low down; while Gardiner places the limit at 32 centimeters.

On the other hand, it sometimes happens that cords, which actually exceed the normal in length, may be so twisted about the child as to become practically too short. When a coil encircles the neck, Gardiner estimates that the cord must measure 76 or 101 centimeters in length in vertex and breech presentations, respectively, if it is not to exert traction upon the placenta. Accordingly, one distinguishes between absolute and relative shortness of the cord. Either of these conditions may give rise to dystocia. Brickner, who has carefully studied the subject, states that delivery cannot occur under such circumstances unless one of the following accidents occurs: separation of the placenta, inversion of the uterus, umbilical hernia of the fœtus, or rupture of the cord, the last two being of infrequent occurrence.

Rupture of the cord may result from absolute or accidental shortness, being due to the former in Dyhrenfurth's, and to the latter in Ahlfeld's case, in which the cord measured 44 centimeters in length, but was tightly twisted about the fœtus. Ordinarily an excessively long cord exerts no deleterious influence, although it predisposes to the formation of loops during pregnancy and to prolapse at the time of labor.

Knots of the Cord.—It is customary to distinguish between false and true knots, the former being due to developmental abnormalities in the cord, while the latter result from the active movements of the child. True knots occur very frequently, and occasionally are of the most complicated character. Ordinarily they are of no clinical importance, but occasionally they may be pulled so taut as to compress the vessels and lead to asphyxia of the fœtus.

Loops of the Cord.—The cord frequently becomes wrapped around portions of the fœtus, and in every third or fourth case of labor the child's neck will be found loosely encircled by one or more loops. In rare instances these may produce strangulation. Most of these accidents are not due to any drawing taut of the loop, but rather to the fact that it does not become looser in proportion as the neck of the child increases in size. In other cases loops of the cord may so tightly encircle the body or one of the extremities of the child as to give rise to deep depressions, which in extreme cases may eventuate in the strangulation or gangrene of the affected part.

In single-ovum twins, in which the amniotic partition wall has already been broken through, it sometimes happens that the cord of one fœtus may become wrapped around some portion of the other so tightly as to cause its death. A number of cases of this character have been collected by Hermann.

Torsion of the Cord.—As the result of movements on the part of the fœtus, the cord may become more or less twisted. Occasionally the torsion is so marked as to interfere seriously with the circulation. The most extreme degrees occur only after the death of the fœtus, Schauta having reported a case in which 380 twists were noted. In rare instances separation of the cord is produced, though this is possible only after the death of the fœtus in the early months of pregnancy.

Inflammation of the Cord.—As long as the child is alive inflammatory conditions are rarely noted, but after its death the whartonian jelly may be found infiltrated with leukocytes. Particularly in syphilis, obliterative changes occur in the vessels, the lumina becoming almost completely occluded, with leukocytic infiltration of the spaces between the muscle fibers in the adventitia, as well as in the adjacent whartonian jelly. Such changes are incorrectly considered to be syphilitic in origin; but this is by no means always the case, as Siddall was able to demonstrate their presence in 60 out of 1000 cords from the children of women who presented no evidence of the existence of that disease. Furthermore, as most of the cases occurred when the labor was prolonged, or complicated by premature rupture of the membranes, or by intrapartum infection, he held that the condition was due to pyogenic bacteria.

Varices of the Cord.—In rare instances *varices of the cord* may rupture as the result of undue pressure. Meier has reported a case in which the death of the fœtus was attributable to such an accident.

Tumors of the Cord.—Tumor formations implicating the cord are rarely seen. Hematomata occasionally result from the rupture of a varix with subsequent effusion of blood into the cord. In one instance I observed such a tumor, 5 centimeters in diameter, at the fœtal end of the cord. Myxomata and myxosarcomata have also been described. Winckel has reported two cases of sarcoma of the cord, while Budin has described a typical dermoid. The cases of Meyer and Haendly were of peculiar interest. In both instances a typical teratoma, the size of a child's head, containing derivatives of all three germ layers, originated from the cord 10 centimeters beyond its fœtal insertion.

Cystic structures occasionally occur in the course of the cord, and are designated as true and false cysts respectively, according to their mode of origin. The former are always quite small and, according to Kleinwächter, may be derived from remnants of the umbilical stalk or of the allantois; while the latter may attain a considerable size and result from liquefaction of the whartonian jelly. Haas has collected the literature concerning the latter variety up to 1906. As a rule such cysts are only apparent, and result from the liquefaction of the myxomatous tissue of the cord.

Edema of the Cord.—This condition is rarely noted by itself, but is frequently associated with edematous conditions of the fœtus. It is very common in dead and macerated children. In one of my cases, in which the child was born alive at full term, the cord was 3 centimeters in diameter and resembled an eel in appearance. Microscopic examination showed that the condition was simply due to an increase in the amount of whartonian jelly.

DISEASES OF THE FŒTUS

Fœtal Syphilis.—Syphilis is the most frequent cause of fœtal death in the later months of pregnancy, and is usually maternal in origin. The mother may be suffering from the disease at the time of conception, or may contract it during the course of pregnancy, but in either event transmission to the fœtus occurs through the placenta. Contrary to the present trend of opinion, as was stated in Chapter XXV, I believe that in rare instances the disease may be paternal in origin, and is transmitted in some way by the spermatozoa. In such cases the mother will or will not contract the disease according as the father does or does not present an infectious lesion at the time of coitus. Since these are usually absent, the mother escapes, while the fœtus ordinarily becomes inoculated—*Colles' law*. Indubitable evidence of paternal transmission will be lacking until the existence of some "sporal" form of the Spirochæta pallida has been demonstrated, as has been done with the spirochete causing recurrent fever.

It has long been known that a syphilitic infection exerts a most deleterious influence upon the product of conception. In 1915, I stated that it was the most important single factor concerned in the production of fœtal death in hospital practice, and in 1920 I demonstrated that it was responsible for 34 per cent of 302 consecutive fœtal deaths in our service. Usually it leads to the untimely expulsion of a macerated premature fœtus. Less commonly the child is born alive showing distinct manifestations of the disease, while in other cases they do not appear until a later period. It should, however, be remembered that no evidence has been adduced to show that syphilis plays any part in the production of abortion.

It is of the greatest importance that the practitioner should become thoroughly familiar with the characteristic lesions of fœtal and placental syphilis, as upon their recognition the future treatment of the patient often depends. This is a point especially worthy of emphasis, inasmuch as, in consequence of ignorance or design on the part of one or both parents, the first intimation that the physician may have of the existence of the disease is often afforded by the birth of a dead child, or the appearance of syphilitic stigmata in a living one; unless the Wassermann reaction is determined in all pregnant women.

Syphilis not only gives rise to characteristic lesions of the fœtus, but also affects the placenta, so that frequently a diagnosis can be made from an examination of the latter organ. This fact is of special importance in those cases in which the fœtus is born alive, or when an autopsy is not permitted upon a dead child. The appearance of the syphilitic fœtus varies materially according as it is born alive or dead. In either instance it is markedly undersized, and the subcutaneous fat is poorly developed or entirely lacking. In the living child the skin usually presents a dry, drawn appearance, and has a peculiar grayish hue. It is very brittle, especially at the flexor surfaces of the joints, where abrasions readily occur and expose the underlying corium. The skin covering the soles of the feet and palms of the hands is often thickened and glistening, and suggests the condition observed in the hands of washerwomen. In other cases, characteristic pemphigoid vesicles are noted in the same locations. If intra-uterine death has occurred, the fœtus rapidly undergoes maceration, the skin peeling off upon the slightest touch and exposing the underlying discolored corium. Although Gräfenburg states that 80 per cent of macerated children are syphilitic, maceration is by no means pathognomonic, since it occurs whenever a dead fœtus is long retained *in utero*, no matter what the cause of death.

The lesions in the internal organs consist essentially in interstitial changes in the lungs, liver, spleen, and pancreas, and osteochondritis in the long bones. It is generally stated that the lungs frequently contain gummatous nodules. These, however, were lacking in the specimens which I have examined. Usually the lungs are enlarged, pale, and scarcely float when thrown into water. On microscopic examination the alveoli are found filled with cast-off epithelial cells in all stages of fatty degeneration—catarrhal pneumonia, the *pneumonia alba* of Virchow. In other cases the lesion consists in an increase in the interstitial tissue associated with pronounced round-cell infiltration, by which the alveoli are compressed, but do not become quite impervious to air. These changes have been exhaustively studied by Heller.

As the result of hypertrophic cirrhosis, the liver undergoes a marked increase in size, and, accordnig to Ruge, its weight may equal one-tenth or even one-eighth of that of the whole body, instead of one-thirtieth, as usual. Under the microscope there is a marked increase in the connective tissue surrounding the individual lobules and acini, with here and there small areas of round-cell infiltration. Many authorities lay great stress upon the presence of so-called blood inlands—dilated capillaries containing red cells in all stages of development—but in my experience the condition is not pathognomonic.

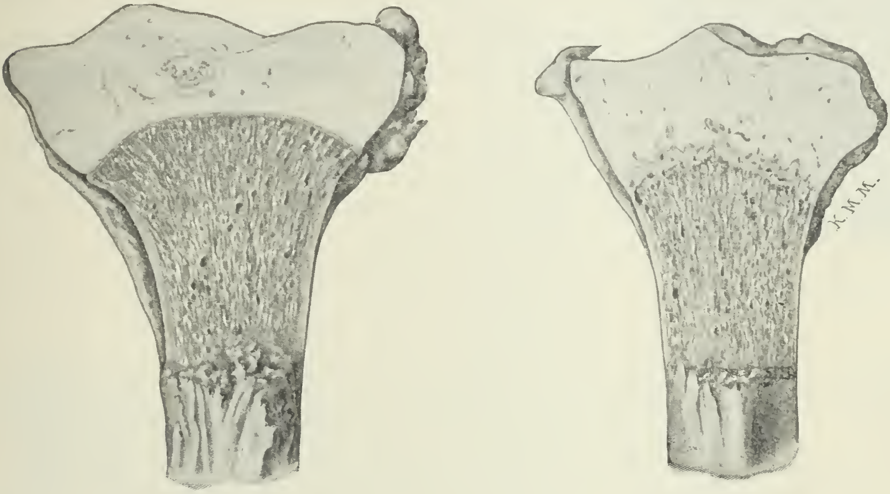


Fig. 535. Fig. 536.

Figs. 535, 536.—Normal and Syphilitic Fœtal Epiphyses. × 2.

The spleen likewise undergoes interstitial changes and increases markedly in size, so that it frequently weighs two or three times as much as usual, which, roughly speaking, is one three-hundredths of the body weight. The pancreas also presents interstitial changes, and is slightly larger than normal.

Prior to the middle of pregnancy, Tissier and Girauld state that the Spirochæta pallida is rarely found, but after that period the fœtus may be said to suffer from a spirochetal septicemia when the parasites may be demonstrated in large numbers in the various organs and blood. They are most abundant in the adrenals, where they are noted in 97.5 per cent of all cases, according to Trinchese, and progressively less frequently in the lungs, pancreas, liver and internal genitalia, respectively.

The recognition of the organic lesions requires some pathological experience, though if the liver and spleen of a macerated fœtus are markedly increased in size and weight the diagnosis is practically assured.

An equally characteristic sign, and one which is readily detected, is afforded by changes occurring at the junction of the epiphysis with the diaphysis in the long bones—Wegner's bone disease. Normally the two are separated by a narrow, whitish, slightly curved line 0.5 to 1 millimeter in diameter—Guérin's line—representing the zone of preliminary calcification, which constitutes the scaffolding upon which the new bone is developed. In syphilis, on the other hand, this becomes converted into an irregular, jagged, yellowish zone 2, 3, or more millimeters in thickness. In advanced cases this alteration is associated with considerable softening and the formation of a soft pultaceous material, which sometimes leads to complete separation of the epiphysis (Figs. 535 and 536).

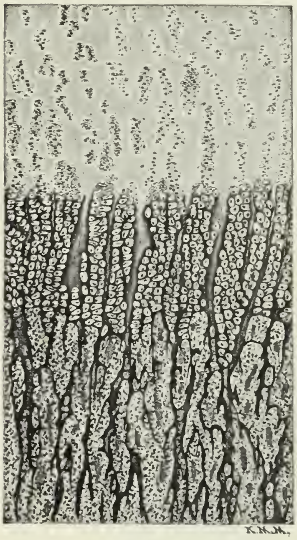


FIG. 537.—NORMAL FŒTAL EPIPHYSIS. × 60.

Upon microscopical examination of the normal epiphysis, as shown in Figure 537, the cartilage cells are found to be arranged in parallel columns at right angles to Guérin's line, while below it is the typical bony structure of the diaphysis with its marrow cavities. The line itself is formed by a deposit of lime salts between the median ends of the rows of cartilage cells, and is gradually invaded by the newly formed bone.

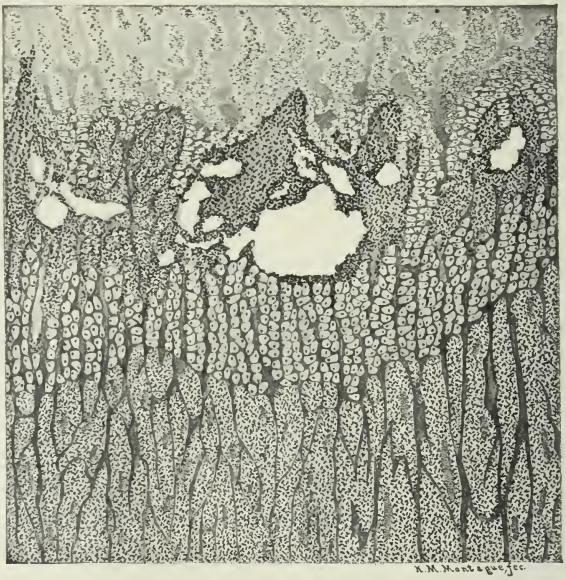


FIG. 538.—SYPHILITIC FŒTAL EPIPHYSIS. × 60.

In syphilis, as is illustrated in Figure 538, the changes are due to an *osteochondritis,* as the result of which there is no longer a sharply marked zone of preliminary calcification between the cartilage and the growing bone; but areas of bone formation, calcification, and leukocytic and small-cell infiltration are found scattered irregularly through the lower portion of the epiphysis, giving an irregular appearance to this region.

These changes, which have been carefully studied by Wegner, and R. Müller, are most readily recognizable at the lower end of the femur, and at the lower ends of the tibia and radius. They are extremely characteristic, and their detection justifies one in making a positive diagnosis and placing the mother under specific treatment. Alexander has shown that the osseous lesions are widely diffused, occurring at the epiphyses of all the long bones, as well as in the phalanges of the hands and feet. Since the demonstration by Shipley and Pearson that the changes can readily be recognized by means of the x-ray, we have utilized the procedure as an accessory means of diagnosis. Accordingly, we take x-ray pictures of all dead children as a matter of routine—partly for diagnostic purposes, but especially to permit comparison between the x-ray, placental, and autopsy findings. Furthermore, they are taken in the case of live children, whenever anything in the history suggests the possibility of the existence of syphilis.

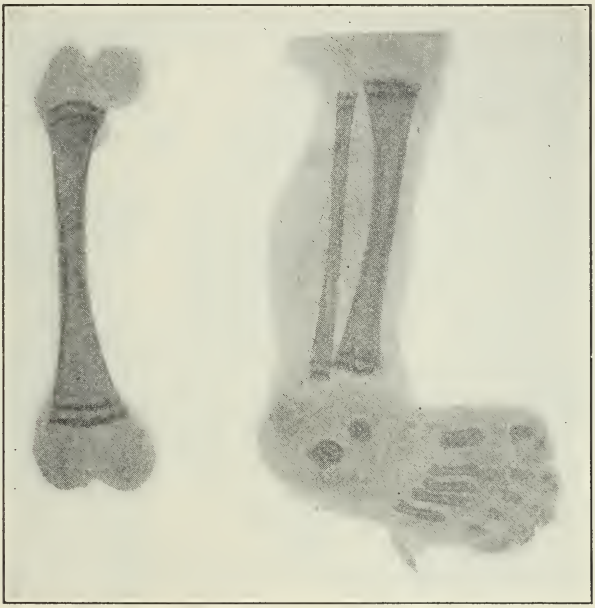


Fig. 539.—X-Ray of Leg Bones of Syphilitic Fœtus.

Many years' experience has convinced me that the procedure constitutes a most valuable addition to our diagnostic equipment, and whenever lesions similar to those depicted in Figure 539 are present that the diagnosis of syphilis is assured.

Placental Syphilis.—Under the influence of syphilitic infection the placenta undergoes characteristic changes. It becomes larger and paler in color, and often presents a dull, greasy appearance. It is always relatively, and frequently absolutely, increased in size, and, according to the researches of Schwab and Levy-Solal, which I can confirm, instead of one-sixth, it may represent as much as one-fourth, one-third, or even one-half of the entire body weight of the fœtus.

Still more characteristic, however, are the changes in the chorionic villi, to which Fränkel called attention in 1873. During the last three or four months of pregnancy when the syphilitic placentæ are teased out in salt solution, the villi are seen to have lost their characteristic arborescent appearance and to have become thicker and more club-shaped (Fig. 541). At the same time there is a marked decrease in the number of blood vessels, which in advanced cases have almost entirely disappeared. This results partly from endarteritic changes, but principally from a proliferation of the stroma cells, which lose their normal stellate appearance, becoming round or oval in shape, and closely packed together.

The changes are still more characteristic when sections made from hardened specimens are studied. As will be seen on comparing Figures 542 and 543, the individual villi are increased in size and almost devoid of blood vessels, while their stroma is made up of closely packed, round, or oval cells. This appearance is so characteristic as to enable one with a little practice to make a positive diagnosis. In my experience, which is based upon the histological examination of many thousand placentæ, such lesions are always associated with the presence of typical organic changes in the fœtus. On the other hand, it must be admitted that negative findings do not necessarily imply the absence of syphilis in the child. The lesions just described afford a satisfactory explanation for the poor development of the fœtus when born alive, and in association with the spirochetal septicemia and the organic involvement readily explain the frequency of a fatal issue.

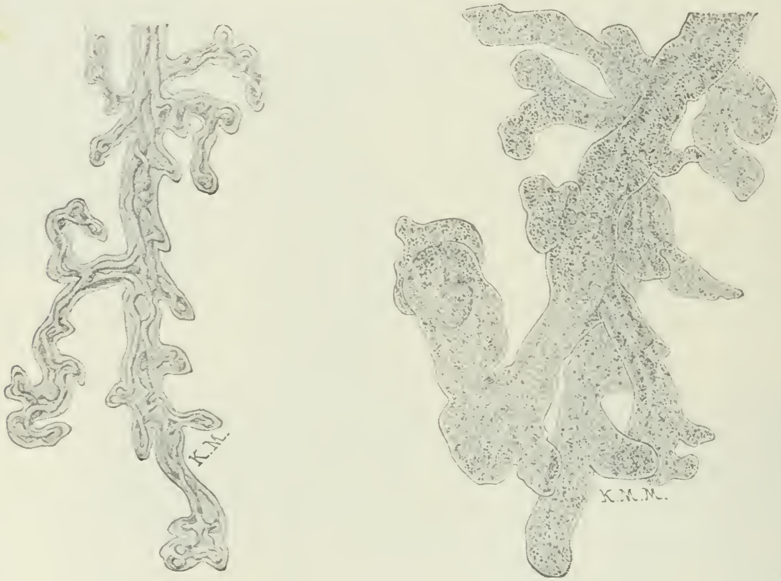


Fig. 540. Fig. 541.

Figs. 540, 541.—Normal and Syphilitic Chorionic Villi Teased Out in Salt Solution, Slightly Magnified.

On the other hand, Mohn, and others believe that the changes just described, while very suggestive, are not absolutely charasteristic; and hold that a positive diagnosis cannot be made unless the presence of the spirochetes can be demonstrated in the placenta. This has been attempted by many investigators, who have found that the spirochetes are so sparsely scattered through the organ that their recognition is most difficult, even when they are present in large numbers in the fœtal organs. Trinchese states that they can always be found, if one is willing to study several hundred sections, but in my clinic Pauli and Emmons were not always so successful. On the other hand, Philipp has shown that spirochetes in motion can be readily demonstrated by examining under the dark field microscope scrapings from the intima of the vessels of the fresh cord.

In my experience the demonstration of a positive maternal Wassermann by no means implies the existence of fœtal syphilis, as in 16 women presenting a positive reaction, but not treated, who were studied in my report of 1920, less than one-half had syphilitic children. Furthermore, a negative maternal Wassermann does not necessarily imply the absence of syphilis, and in the same report, it was stated that approximately every tenth syphilitic fœtus was born of a mother whose Wassermann was negative. Consequently, it is particularly in this type of case that the x-ray of the child and the histological examination of the placenta give valuable information, more especially if an autopsy is not permitted. Observations of this character emphasize the importance of not relying exclusively upon the outcome of the Wassermann reaction in the diagnosis of syphilis, and make it apparent that the utilization of that valuable diagnostic procedure cannot replace accurate clinical observation, as so many are inclined to believe.

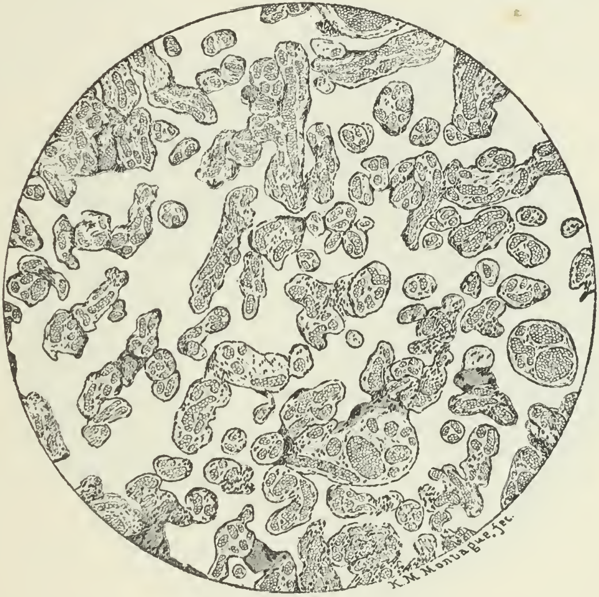


Fig. 542.—Normal Full-Term Placenta. × 50.

For many years, it was our practice to make a routine Wassermann test upon the blood of the fœtus obtained from the umbilical cord, and postive results were obtained in about 1 per cent of approximately 5000 observations. Upon following such children during the first year of life, it was found that a considerable number, who presented a positive Wassermann at birth, subsequently showed a negative reaction and never developed clinical manifestations of syphilis; while, on the contrary, in other instances the original negative reaction subsequently became positive and was accompanied by signs of congenital disease. For these reasons, we have abandoned the practice, as the results obtained did not seem commensurate with the time or expense involved. Fildes and Cruickshank take a similar view, and the latter, in view of the fact that the original positive reaction so often becomes negative later, believes that the bodies which cause the reaction, but not actual syphilis, are transmitted from the maternal to the fœtal blood.

Such qualifications, however, should not be considered as in any way invalidating the usefulness of the routine maternal Wassermann, as it is only by its means, and the subsequent intensive treatment of the mothers presenting a positive reaction that we can expect to cope successfully with the problem of fœtal and congenital syphilis.

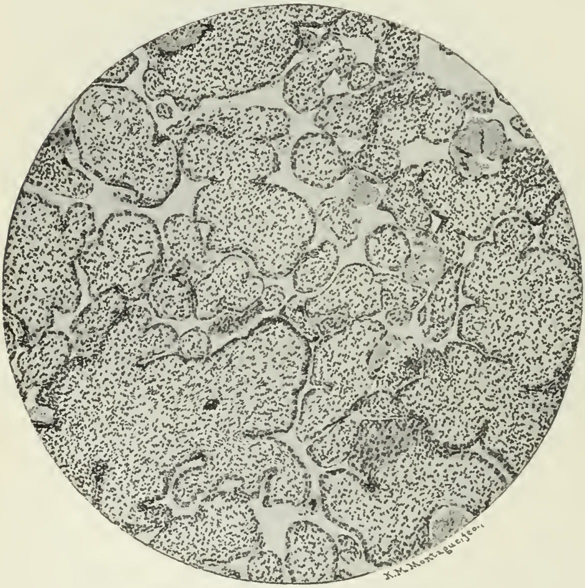


Fig. 543.—Syphilitic Full-Term Placenta. × 50.

It is generally stated that distinct syphilitic lesions, varying from a marked thickening of the membrane to distinct gumma formation, are frequently noted in the decidua. I believe, however, that many of the conditions described as such have no connection with lues, but represent various hyperplastic conditions.

Zilles, and many of the earlier writers, described gummata occurring in the fœtal portion of the placenta. I have never met with them, and am of the opinion that careful histological study will show that the structures designated as such are merely infarcts in various stages of development or degeneration.

Bondi, in 1903, directed attention to changes in the umbilical cord, which he considered very characteristic, and his findings have been confirmed by most subsequent writers. These occur in the vessels, and consist in edema of their walls, and leukocytic infiltration of the spaces between the muscle fibers, as well as in the adventitia, while the intima is more or less thickened. Such changes are undoubtedly present in the cords of many syphilitic children, but in my experience they are not pathognomonic; more especially as Siddall was able to demonstrate their presence in 6 per cent of the cords obtained from a large series of normal women.

General Dropsy of the Fœtus.—In this rare condition, which has been carefully studied by Ballantyne, Schridde, Schumann, and Hartmann, the fœtus and placenta are markedly edematous. As the result of infiltration with serum the former may attain immense proportions and the latter be increased to three or four times its normal size. In two of my cases the placenta weighed 1200 and 1440 grams, respectively, while Cohn has described one which weighed 2900 grams.

Although a good deal has been written upon the subject, no satisfactory explanation of the anomaly has as yet been arrived at. Formerly it was supposed to result from edematous conditions of the mother, but the researches of Ballantyne have shown that this view does not always hold good, and that in the majority of the cases submitted to a thorough study lesions were noted in the organs of the fœtus sufficient to explain the production of the condition. It is interesting to note that in several cases collected by Seifert it was attributed to fœtal leukemia.

The disease always leads to the death of the fœtus, which in no instance survived its birth for more than a few hours. In the majority of cases on record labor was spontaneous, though occasionally the increased size of the fœtus and the placenta may give rise to dystocia.

Other Diseases of the Fœtus.—In most textbooks upon obstetrics numerous morbid conditions of the fœtus are described under the heading Diseases of the Fœtus. The majority of them, however, are of interest mainly from a pathological point of view, and have no obstetrical significance, except when they lead to an increase in the bulk of the fœtus, which in turn may give rise to difficult labor. Accordingly, they will not be considered in this place, although certain of them will be referred to in the chapter upon Fœtal Dystocia.

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CHAPTER XXIX

ABORTION AND PREMATURE LABOR

Spontaneous expulsion of the ovum may occur at any period of pregnancy, and is variously designated according to the degree of development which the product of conception has attained. Strictly speaking, one should distinguish between abortion, miscarriage, or premature labor, respectively, accordingly as the pregnancy terminates before the sixteenth week, between the sixteenth and twenty-eighth week, or at a later period.

Prior to the twelfth week, owing to the imperfect development of the placenta, the entire ovum often comes away intact. From that time on, however, the placenta forms a definite organ and the expulsion of an intact ovum is exceptional, the fœtus, as a rule, being extruded first, and followed after a longer or shorter period by the placenta and membranes. After the twenty-eighth week the course of labor differs but little from that observed at full term, and the child, if properly cared for, may survive; its chances of so doing increasing in almost geometrical proportion with every additional week.

As the term *abortion* is somewhat suggestive of a criminal procedure, it is rarely employed in popular parlance, all cases terminating prior to the period of viability being designated as a miscarriage. Among medical men, on the other hand, the latter term is but little used, and it is customary to speak of all cases ending before the twenty-eighth week as abortions.

ABORTION

Frequency.—It is difficult to arrive at accurate conclusions concerning the frequency with which spontaneous abortion occurs. Reliable vital statistics are not yet available in America, and, inasmuch as only women who are more or less seriously ill following abortions enter hospitals for treatment, the statistics based upon their records would give too low an estimate—in my service between 8 and 10 per cent of all patients. Unfortunately, sufficiently large series from private practice are not available; though Malins found that 19.23 per cent of the pregnancies of 2000 patients ended in abortion. A conservative estimate would indicate that about every fifth or sixth pregnancy in private practice ends in spontaneous abortion, and the percentage would be increased considerably were the very early cases taken into account, in which a profuse loss of blood follows the retardation of the menstrual period for a few weeks. It is impossible to give accurate figures concerning the frequency of criminal abortion in this country, but it is generally admitted that it is becoming increasingly frequent in all classes of society.

Following the World War the increase has become alarming in Germany, where according to Liepmann over a half million abortions are done each year and lead to the death of 25,000 women. In certain communities almost as many abortions occur as labors, and Nevermann states that in 1926, 15,000 abortions and 16,000 labors were reported in Hamburg, and estimates that at least four-fifths of the former were criminally induced.

Etiology.—In the early months of pregnancy spontaneous expulsion of the ovum is nearly always preceded by the death of the fœtus. For this reason, the consideration of the etiology of early abortion practically resolves itself into determining the cause of fœtal death. In the later months, on the other hand, the fœtus is frequently born alive, and other factors must be invoked to explain its expulsion. Fœtal death may be due to abnormalities occurring in the ovum itself, to abnormalities of the generative tract, or to systemic disease on the part of the mother and now and again of the father.

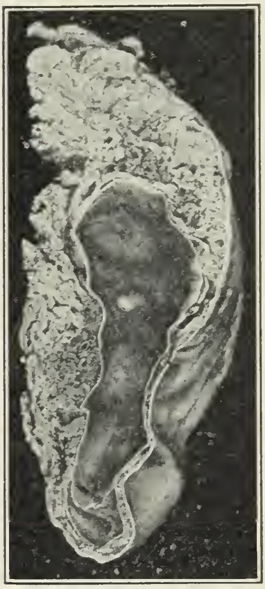

Fig. 544.—Abortion Due to Defective Germ Plasm. × 1.
Note degenerated embryo in center.

(*a*) The most usual cause for the death of the fœtus is to be found in abnormalities of development, which are inconsistent with life. The investigations of Mall indicate that such conditions are present in one-third of all early abortions, and would have resulted in monstrosities had pregnancy continued. We are as yet completely ignorant concerning the causation of such abnormalities in human beings, but reasoning from the results obtained in experimental teratology, it would seem probable that two main sets of factors are concerned:—abnormalities in the earliest stages of segmentation of the ovum, and changes in its environment.

Pending more precise knowledge, abnormalities in the early stages of segmentation are attributed to defective germ plasm, which of course implies that the defect may originate in the germ cells of mother or father, or of both. In many such cases the embryo is lacking or is represented by a formless mass of tissue, while the fœtal membranes appear normal. In such circumstances, it would seem that the defect had implicated the cells making up the internal cell mass, but had not affected the main body of trophoblast from which the membranes are formed. On the other hand, the entire trophoblast may be implicated, and Grosser considers whenever the entire periphery of chorionic vesicles, under 5 centimeters in diameter, is not thickly covered with villi that we have to deal with a primary trophoblastic defect, and consequently that normal development will not occur.

The most conclusive evidence in favor of defective germ plasm is afforded by the occurrence of double-ovum twins, in which one vesicle contains a normal and the other a rudimentary embryo. In such cases the abnormality cannot be attributed to a defect in implantation, as both ova were implanted upon the same decidua. In most cases, however, the evidence is more inferential and is based upon the condition of the embryo as contrasted with the rest of the product of conception. In this way Streeter concluded that defective germ plasm was the essential cause for 81 out of the 104 abortions reported by Huntington. Even when the abortion is produced by the action of chemical agents, a similar explanation may be invoked, as Datnow found when they are provoked in rabbits by colloidal lead that changes in the trophoblast constitute the striking feature.

That changes in environment may give rise to abnormalities of the embryo has been shown experimentally, as Stockard found that temporary reduction in the supply of oxygen, or radical changes in temperature, may lead to the death of the embryo or to such retardation of growth as to cause the production of monstrosities. Furthermore, the experiments of Steffko, in women, showed that alteration in the hydrogen-ion content of the uterine contents, following the introduction of fragments of silkworm gut, led to degenerative changes in the embryo and its surrounding membranes. Moreover, it is probable that the failure of pregnancy to progress in the absence of vitamine E, as shown by Evans, may be attributed to similar disturbances. Indeed, Vogt, in 1929, suggested that avitaminosis plays a prominent part in the causation of abortion, and should be particularly borne in mind whenever repeated abortions occur without appreciable cause.

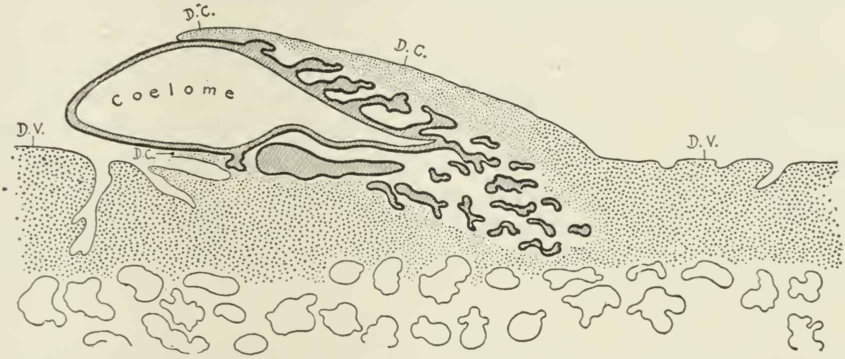

Fig. 545.—Diagram Showing an Ovum in the Act of Aborting, 38 Days from Onset of Last Menstrual Period.

The free pole is emerging through the ruptured decidua capsularis, while the other pole is still in connection with the decidua. *D. C.*, decidua capsularis; *D. V.*, decidua vera.

Naturally, the changes just considered are involved only in the causation of fœtal death early in the course of pregnancy. At a somewhat later period it may result from changes in the appendages of the ovum, such as excessive torsion of the cord, hydramnios or hydatidiform mole. In the last-named affection the nutritive material conveyed to the intervillous spaces by the maternal blood merely suffices to nourish the hypertrophic villi, little or none remaining to be transmitted to the child.

Figure 545 is a diagrammatic reconstruction of an early ovum in the act of aborting. The specimen was discovered accidentally in a uterus removed thirty-eight days after the onset of the last menstrual period. Although no symptoms of impending abortion were observed, it was clearly inevitable, as one pole of the ovum was emerging through the ruptured decidua capsularis. The process must be regarded as conservative, as the ovum was hopelessly abnormal, no trace of an embryo being discoverable in the cœlomic cavity, while some of the villi presented the changes characteristic of hydatidiform mole.

Still later in pregnancy, certain diseases and abnormalities of the placenta may lead to the same result. Thus, Merttens and Franqué have described an obliterating endarteritis in the vessels of the chorionic villi, independent of syphilis, which interferes with the fœtal circulation to such an extent as to be incompatible with life. In other cases, the abundant formation of red or white infarcts may throw so large a portion of the placenta out of function that the remainder is not sufficient to supply the needs of the fœtus. Furthermore, such abnormalities as placenta prævia, low implantation of the placenta, or velamentous insertion of the cord, as well as premature separation of the placenta, may likewise bring about circulatory conditions inconsistent with fœtal life.

Syphilis is usually mentioned as one of the most frequent factors concerned in the production of abortion. In my experience, it plays but little part during the first half of pregnancy, but, on the other hand, it constitutes the most important single factor in the etiology of premature labor. Support is lent to this view by the fact that no one as yet has been able to demonstrate the presence of spirochetes in the tissues of fœtuses expelled by syphilitic mothers during the first third of pregnancy, but all observers agree that they can be found with increasing frequency in each successive month of the second half.

Diseases of the maternal kidneys, heart, liver and lungs are rarely concerned in producing abortion, but, as will be indicated below, they play a prominent part in the causation of premature labor.

(*b*) As was pointed out in the chapter upon the Accidental Complications of Pregnancy, all acute infectious diseases have a tendency to bring about the death of the child and its subsequent expulsion from the uterus. The fatal result is usually due to the transmission of toxins, and occasionally of the specific micro-organisms from the mother to the child. Poisoning with phosphorus, lead, illuminating gas, and other substances may lead to similar results.

Fœtal death is sometimes attributable to malnutrition on the part of the mother, although the fact that the frequency of abortion is not increased during times of famine indicates that it must be very exceptionable. Furthermore, it is not unusual for women suffering from wasting diseases to give birth to fully developed children.

(*c*) Generally speaking, abnormalities in the generative tract play a much less important part in the etiology of abortion than was formerly believed; although developmental anomalies of the uterus, or imperfect development of the normally formed organ, may be responsible for conditions which are unfavorable for the implantation of the ovum and later for the development of the placental circulation. Chronic metritis is supposed to act in the same way. Dense adhesions about the tubes and ovaries, resulting from inflammatory processes, only rarely interfere with the expansion of the uterus sufficiently to give rise to abortion, since in most cases the bands of adhesions gradually stretch and become elongated.

Displacements of the uterus, more particularly retroflexion and prolapse, are justly considered as important factors in the causation of abortion. As a rule, the interruption of pregnancy is due less to the abnormal position of the uterus than to lesions of its lining membrane resulting from circulatory changes incident to it. In the rare cases of incarceration, however, the accident must be attributed to pressure exerted by the surrounding parts upon the abnormally placed organ.

The most important condition of the generative tract leading to the production of abortion consists in diseases and abnormalities of the decidua. In the hypertrophic form of decidual endometritis—decidua polyposa—the bulk of the maternal blood brought to the uterus goes to nourish the hyperplastic decidua, while in the atrophic forms the conditions are unfavorable for the implantation of the ovum and the development of the placenta. More important still is the part played by chronic glandular hyperplasia and acute inflammation of the decidua. These lesions are frequently accompanied by hemorrhagic changes, and, excepting the ill-defined conditions which are responsible for defective development of the embryo, are the most frequent causes of abortion in the early months. Histological examination demonstrated the presence of acute or chronic decidual endometritis in 70 per cent of my specimens, but in many instances it was impossible to determine whether it was the primary cause, or merely an accidental complication. The occurrence of abortion associated with the presence of myomata in the walls of the uterus must be attributed less to the mechanical effect of the tumor itself than to changes in the decidua incident to it.

(*d*) In a few cases the cause of abortion is to be sought for in reflex influences, which take their origin from lesions of the generative tract or from irritative conditions about the breasts. In very rare instances the accident is attributed to intense mental emotions—anger, fright, or grief.

It is customary to distinguish between *predisposing* and *exciting causes* of abortion. The various factors to which allusion has just been made predispose to abortion, while the exciting cause is often of a mechanical nature, such as a slight fall, jar, or overexertion. The statements of the patient concerning such predisposing causes, however, must be received with caution, as they are usually merely incidental and have no connection with the actual cause. At the same time, it must be admitted that the apparently healthy uterus sometimes possesses an abnormal degree of irritability, and will react to stimuli, which ordinarily would be without effect. In such women the slightest violence, such as coitus, a simple bimanual examination, a misstep, tripping over a carpet, or a ride over a rough road, may bring on an abortion; while in others the most violent exercise and the rudest manipulations may be borne with impunity. For example, every physician can recall cases in which a sound has been introduced into the pregnant uterus without ill effects, and it is well known that, in the later months, the repeated introduction of a large bougie, or even of a Champetier de Ribes balloon, may fail to bring about satisfactory uterine contractions.

(*e*) Formerly, syphilis was mentioned as the chief paternal cause of abortion. As has already been indicated, this disease plays little or no part in the interruption of pregnancy during its first half. On the other hand, evidence is accumulating that excessive and long-continued use of alcohol, lead intoxication, and other forms of chronic poisoning may so effect the vitality of the spermatozoa that, although the process of fertilization may proceed normally, the product of conception is incapable of continued normal development.

It is not unusual to meet with women who give a history of repeated abortion occurring at about the same time in a number of successive pregnancies. In some such cases careful examination will demonstrate the existence of an endometritis or a uterine displacement; and it is only after the cure of the underlying condition that subsequent pregnancies can be expected to progress to full term. In other instances no such lesions exist, and the treatment of such patients must remain empirical, unless anatomical examination of the product of conception shows that the repeated accidents were due to defective germ plasm. At present there is a tendency to regard repeated abortion as a manifestation of abnormal function of certain of the ductless glands, but as yet satisfactory evidence has not been adduced in support of such a view.

The experimental work of Reynolds and Macomber upon the effect of dietary factors in the causation of sterility, the discovery of vitamine E by Evans, as well as the experience of animal breeders, suggests the possibility that the prolonged use of defective diet, while not interfering with fertility, may so affect that vitality of the germ cells that the product of conception will be able to attain only a certain stage of development before succumbing. With that in mind, it is advisable in suitable cases to make inquiries concerning the dietetic habits of the patient and her husband, and occasionally to administer cod liver oil for long periods.

After Bang, McFayden, Theobald Smith and others had directed attention to the epidemic form of abortion which occurs in cattle, and had shown that it is due to one of several specific micro-organisms—the *Bacillus abortus* of Bang and the *Vibrio fœtus* of Smith—it was suggested that repeated abortions in women might be susceptible of a similar explanation, more particularly after it had been shown that the same micro-organism is concerned in the production of Malta fever. Such a view was abandoned for two reasons: First, that there is no similarity between the conditions in cows and women; for in the former the infection almost invariably leads to permanent sterility; while in women the possibility of conception is in no way affected, but each succeeding pregnancy ends in abortion at about the same period as its predecessor. In the second place, there is no evidence of the infectious nature of repeated abortions in women, nor of the transfer of the disease from one individual to another. Furthermore, bacteriological examination has failed to reveal the presence of analogous micro-organisms, and while bacteria are frequently found in the uterus of such patients they are simply the well-known pyogenic or putrefactive varieties. Complement-fixation tests carried out by Williams and Kolmer have likewise failed to show that the *Bacillus abortus* plays any part in the causation of abortion in women.

Those interested in further details concerning infectious abortion in cattle are referred to the several publications of Theobald Smith, and to W. L. Williams' textbook upon veterinary obstetrics.

Pathology.—In spontaneous abortion, the immediate cause of the expulsion of the ovum is to be found in hemorrhagic changes in the decidua. Concerning their mode of production we must confess a profound ignorance, except when endometritis is the underlying cause. These changes, which are most marked in the decidua basalis, are followed by degeneration of the affected tissues, as the result of which the attachment of the ovum becomes more or less loosened, and the product of conception comes to act as a foreign body, and gives rise to uterine contractions, which, after a long or shorter period, finally lead to its expulsion.

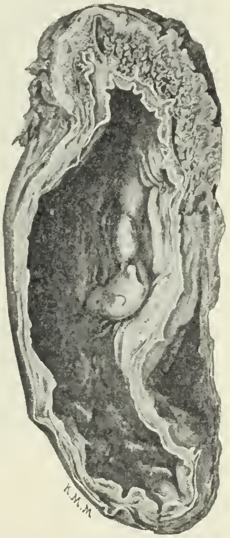

Fig. 546.—Early Abortion, Showing Decidua Capsularis and Basalis with Degenerate Embryo. × 1.

Especially in the early months, the entire ovum may be expelled after a few premonitory symptoms, and frequently the entire decidual lining of the uterine cavity is cast off with it. In such cases a triangular sac comes away which represents the decidua vera, which contains in its interior the vesicular ovum, enclosed in the decidua capsularis. More frequently, however, the decidua vera remains *in utero,* while the ovum, surrounded by the decidua capsularis, is expelled. Occasionally the latter is torn through, and, together with the decidua vera and basalis, is retained *in utero,* while the shaggy, more or less spherical chorionic vesicle is cast off. As pregnancy advances, the expulsion of the entire ovum is observed less frequently, so that after the fourth month it is the rule for the membranes to rupture and the fœtus to be expelled by itself, to be followed, spontaneously or not, by the placenta and membranes.

In many early abortions, the expelled ovum is a thin-walled cystic structure, filled with clear fluid and containing a minute degenerated embryo, or only a remnant of the umbilical cord. This condition represents an early stage of hydramnios, and corresponds to the dropsical or blighted ovum of the early writers. In other cases, the ovum is represented by a more or less elliptical structure with a shaggy blood-stained exterior. On section its walls vary considerably in thickness, with a thicker portion representing the placenta, and a more extensive but thinner portion, representing the decidua capsularis, the chorion læve and the amnion. In many instances, the amniotic sac is relatively large, while the embryo is represented by a minute mass of tissue, whose component parts cannot be differentiated (Fig. 546).

In many instances, the process of abortion occurs very slowly, so that the blood poured out between the periphery of the ovum and the decidua has an opportunity to coagulate. Under such conditions, the ovum on its expulsion is surrounded by a capsule of clotted blood of varying thickness with degenerated chorionic villi scattered through it. In its interior is a small cavity filled with clear fluid and lined by a thin, glistening membrane (the amnion), from one point of which hangs the umbilical cord and the degenerated fœtus. Such structures are classified as *blood or carneous moles,* according to their appearance. In the former the capsule of coagulated blood is red in color, while in the latter it presents a paler appearance, the result of fibrin formation (Fig. 547).

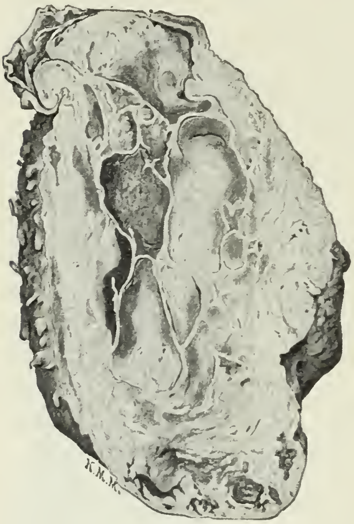

Fig. 547.—Section through Blood Mole. × 1.

Now and then the interior of such structures, instead of being lined by the smooth amnion, may present an irregular nodular appearance, which is due to the formation of hematomata of varying size beneath the amnion and chorionic membrane. This condition, to which Granville, in 1834, applied the term *ovum tuberculosum,* has been more particularly studied by Breus, who designated it as *tuberous subchorial hematoma* of the decidua (Fig. 548); while Berry Hart, and Taussig described the condition as hematoma mole, or tuberous fleshy mole, respectively. Breus believed that the tuberous appearance was the result of hemorrhage into collapsed folds of the amnion. Davidson and Taussig take the view that the disproportion between the size of the fœtus and the ovum is the result of hydramnios, and after the death of the former the amniotic fluid is gradually absorbed, when the redundant amnion is thrown into folds, the blood being effused into their interior. Routine examination of the tissues expelled at the time of abortion show that the hematoma moles are by no means so uncommon as was previously thought.

In all uterine moles the fœtus is either lacking or is smaller in size than would naturally correspond with the menstrual history. This fact indicates that the process is of gradual formation, and that a considerable period had elapsed between the death of the fœtus and the expulsion of the ovum. Not uncommonly, indeed, the fœtus may undergo complete dissolution, or be represented merely by a stub of umbilical cord hanging from the interior of the ovum. In the former event, after resorption of the amniotic fluid, the ovum may be represented by a solid mass of varying size, composed of the collapsed amniotic cavity and of chorionic villi embedded in coagulated blood.

Dissolution of the dead fœtus is possible only in the early weeks of pregnancy. In abortions occurring after the fœtus has attained any considerable size, several outcomes are possible. In the first place, the amniotic fluid may be absorbed, when the fœtus becomes compressed upon itself and assumes a desiccated appearance—fœtus compressus. At the same time the placental circulation becomes abolished, infarction results, and the whole structure takes on a dry, whitish appearance. Occasionally, the fœtus becomes so dry and compressed as to resemble parchment, when the process is designated as mummification. Although this is rarely observed in ordinary abortion, it occurs relatively frequently in twin pregnancy, particularly when one fœtus has died at an early period, while the other has gone on to full development—fœtus papyraceus.

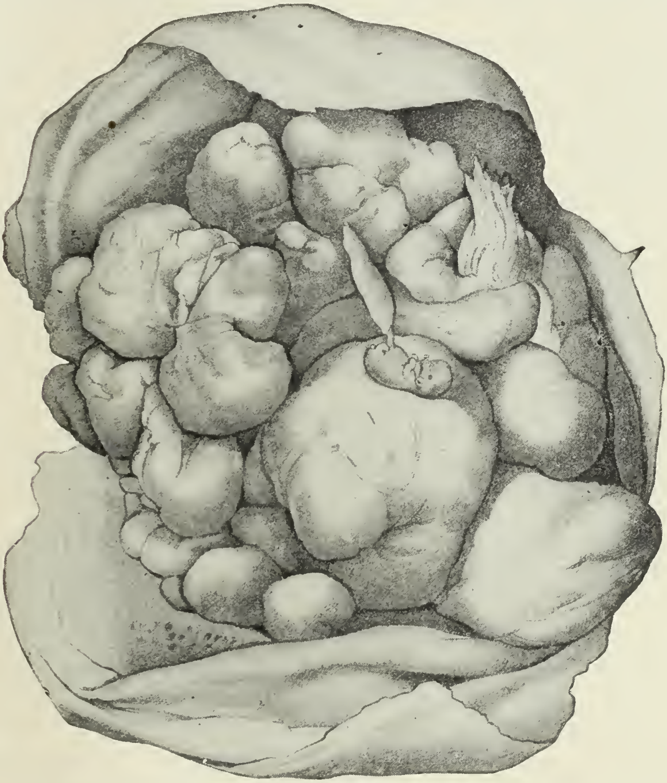

Fig. 548.—Tuberous Subchorial Hematoma (Breus). × 1.

In other cases the retained fœtus may undergo *maceration*. In such circumstances, the bones of the skull collapse, the abdomen becomes distended with a blood-stained fluid, and the entire fœtus takes on a dull reddish color due to staining with blood pigment. At the same time the skin softens and peels off at the slightest touch, leaving behind the bright-red corium. The internal organs degenerate, and become soft and friable, losing their capacity for taking up the usual histological stains.

Very exceptionally, and particularly when the membranes have long since ruptured and a mild but chronic infectious process has become established, the soft parts of the embryo may undergo dissolution and digestion, so that when the process is terminated all that remains is the skeleton, which sometimes resembles a shrimp more nearly than a fœtus. Once in many thousand cases, although I have never observed it, the fœtus may be retained *in utero* for a long period, until the deposition of lime salts converts it into what is known as a *lithopedion*. This phenomenon is relatively common in certain lower animals, and is recognized, but rare, termination of extra-uterine pregnancy.

Clinical History.—The onset of abortion is usually preceded by certain premonitory symptoms, the most important of which are hemorrhage and pain in the back and lower abdomen. Loss of blood, no matter how slight, in the early months of pregnancy, should always be regarded with suspicion, for, if it be not a premonitory symptom of abortion, it usually indicates the existence of a decidual endometritis, or an abnormal implantation of the placenta. When due to the former, the discharge is usually not very profuse, and is of a dirty brown or brownish-red color, while when due to the latter it is apt to be more profuse and distinctly bloody in character. The premonitory bleeding may persist for weeks, or be promptly followed by the expulsion of the ovum. Indeed, in some cases the latter event may occur so rapidly as to surprise the patient.

When a patient in the first months of pregnancy begins to lose blood, and the flow is associated with pain in the lower abdomen and back, an abortion is *threatened*. It, however, does not become *imminent* unless the hemorrhage is profuse or the cervix considerably dilated; even in the latter event it is not impossible for the disturbance to subside, and for pregnancy to go on without interruption. On the other hand, rupture of the membranes and escape of the liquor amnii indicate that abortion is *inevitable*.

When abortion becomes imminent, the hemorrhage is usually quite profuse, though as a rule not sufficient to endanger the life of the woman. At the same time she experiences severe cramplike pains in the abdomen due to the uterine contractions, which later become distinctly bearing-down in character. After the cervix has become sufficiently dilated, the detached ovum may be expelled intact from the uterus, and when not retained in the vagina comes away spontaneously. This is known as *complete abortion*. More frequently, the fœtus alone is expelled, while the placenta and membranes remain in the uterus—*incomplete abortion*. In the latter event the hemorrhage usually persists until the retained structures are extruded spontaneously or are removed artificially, though the pains usually cease with the expulsion of the fœtus.

After the uterus has rid itself of the product of conception, the hemorrhage and pain cease, and a process of involution begins, identical with that observed after full-term labor. In my experience spontaneous complete abortion occurs most frequently during the first three months of pregnancy. In 197 spontaneous abortions occurring in my service and analyzed by Titus, the relative incidence of the complete to the incomplete variety was in the ratio of one to five. Such figures, however, understate its frequency; as the symptoms following many complete abortions are so trifling that the women due not think it necessary to enter the hospital, and usually do so only because of profuse hemorrhage or infection incident to the incomplete extrusion of the fœtal membranes, so that I estimate that a ratio of one to three would be more in accordance with the actual facts.

Treatment.—Prophylactic treatment is most important, although, as a rule, it is not available in women aborting for the first time. After the patient has recovered from an abortion, a careful local and general physical examination should be made, and, in case any abnormality is discovered, the necessary curative or precautionary measures should be instituted before renewed conception occurs. If the uterus is retroflexed, the organ should be replaced and held in position by a properly fitting pessary. If the desired results are not obtained in this way, the uterus should be suspended by a suitable operation. If endometritis be present, curettage should be done, and the patient warned against becoming pregnant until sufficient time has elapsed to allow the uterus to recover from the morbid condition.

If past experiences has shown that the uterus is irritable and that the patient is predisposed to abort upon the slightest provocation, coitus should be interdicted during pregnancy, and the patient be cautioned against overexertion, particularly upon the days during which the menstrual period would ordinarily occur, and be encouraged to lead a careful, well-ordered existence. Occasionally, the only means of leading the process to a successful termination is by keeping the patient in bed throughout pregnancy.

Treatment of Threatened Abortion.—Whenever symptoms of threatened abortion appear, the patient should be put to bed. If pains occur, a hypodermic injection of ¼ grain of morphine should be administered at once, to be followed by 1-grain rectal suppositories of extract of opium, repeated at intervals of four or six hours. Better results are sometimes obtained by combining opium with the extract of hyoscyamus. The following suppository, administered every six hours, often serves a useful purpose:

℞	Codein. sulph.	gr. ss.
	Ext. hyosc.	gr. i
	Ol. theobrom.	q. s.

In many instances the symptoms rapidly subside under such treatment, but the patient should be kept in bed for some days after their disappearance, in the hope of avoiding any repetition. Unless the loss of blood is excessive it is unwise to subject the patient to a thorough pelvic examination during the first few days for fear that the manipulation may convert a threatened into an inevitable abortion. On the other hand, exploration should not be too long deferred, as occasionally similar symptoms are associated with extra-uterine pregnancy, and the failure to recognize the tubal swelling may result in postponing operative interference until after rupture has taken place into the peritoneal cavity.

In other cases, the pain yields to the administration of sedatives, but the hemorrhage persists, and we then have to decide how long we are justified in permitting the bloody uterine discharge to continue, and whether there is any probability that the pregnancy will progress normally. So long as it does not exceed that usually observed at the menstrual period, the flow is not necessarily incompatible with the continuance of pregnancy, and may be permitted to go on for some time.

In view of the part played by developmental abnormalities of the fœtus in the production of abortion, it is apparent that in many instances its occurrence should not be regarded as a misfortune, but rather as a conservative effort on the part of Nature to rid the organism of a product of conception which cannot attain maturity. For this reason I am of the opinion that palliative treatment is frequently continued unnecessarily long. Consequently, if the symptoms do not disappear within ten days, the patient should be allowed to assume her usual avocations, in the hope that the threatened abortion will become inevitable. On the other hand, if the bleeding at any time becomes so profuse that the patient begins to show signs of anemia, the uterus should be at once emptied by the methods to be described below. In occasional instances, notwithstanding appropriate treatment and rest in bed, slight hemorrhage may persist for weeks, and it then becomes essential to ascertain whether there is any possibility of the pregnancy continuing. Unfortunately, this problem cannot be solved at once, but necessitates a delay of several weeks and repeated bimanual examinations. Thus, if at the end of two or three weeks one is convinced that the uterus has not increased in size, or has even become smaller, one is justified in concluding that the fœtus has perished; while, on the other hand, an increase probably indicates that it is still alive, but does not necessarily mean that pregnancy will go on to a happy termination. As soon as we are convinced that the fœtus is dead, the uterus should be emptied. In such cases nothing can be gained by delay, as abortion will inevitably occur sooner or later, whereas temporizing entails a waste of time and sometimes exposes the patient to serious danger.

Treatment of Inevitable Abortion.—When convinced that abortion is inevitable, and particularly when the hemorrhage is profuse, the uterus should be emptied in the most conservative manner, the choice of procedure depending upon the consistency and the degree of dilatation of the cervix. If it be sufficiently patulous to admit a finger, the patient should be anesthetized, brought to the edge of the bed, and prepared for operation. After preliminary dilatation of the outlet, the carefully sterilized hand, annointed with sterile albolene or green soap solution, is introduced into the vagina, and one or preferably two fingers are carried up into the uterine cavity, and, under the guidance of the other hand applied over the abdomen, peel off the ovum from the uterine wall and slowly extract it. If this cannot be effected, the ovum should be broken up by the finger, and its fragments extracted by means of a placental or ovum forceps, under the guidance of a finger within the uterus.

If, however, the cervix is soft, but not sufficiently dilated to permit the introduction of a finger, sufficient dilatation may be effected by means of Hegar's or Goodell's dilators. Such mechanical dilatation should always be done slowly, as the employment of undue force frequently results in cervical tears, whose extent cannot be regulated, and which offer an additional portal of entry for infection. In such cases, general anesthesia can advantageously be replaced by the injection of a 1 per cent novocaine solution into the cervical and pericervical tissues by means of a long needle.

On the other hand, if the cervix is too rigid for such dilatation, its canal, as well as the vagina, should be packed tightly with a narrow sterile gauze bandage, as described in Chapter XXIV. When removed at the end of twenty-four hours, the pack frequently brings with it the intact ovum; but even if this does not occur, the cervix will generally be sufficiently dilated to permit the introduction of the finger, when the ovum can be removed as recommended above. Dilatation of the cervix by means of a laminaria tent is recommended by many authorities. While it effects that purpose very satisfactorily, I deprecate its employment, as I know no way by which it may be rendered absolutely sterile. If, however, haste is essential in such circumstances, I perform vaginal hysterotomy in preference to forcible dilatation by means of a metallic dilator.

I always feel more comfortable whenever it is possible to explore the uterine cavity with the finger after completing the abortion. No doubt the uterus can be satisfactorily evacuated in most cases by means of the curet and polypus forceps, but no instrument has ever been invented which will prove an efficient substitute for the carefully trained sense of touch when it becomes necessary to satisfy one's self that no remnants of the ovum are still retained in the uterus. On several occasions I have seen patients profoundly exsanguinated following the supposedly thorough removal of the product of conception by curettage, but, on introducing the finger into the uterus, I have found that it still contained the bulk of the ovum. Experiences of this kind have therefore led me to do away with the use of instruments as far as possible. Moreover, in addition to the fact that they fulfill their object only imperfectly, they are not devoid of danger. Every gynecologist is familiar with cases in which the softened uterus has been perforated by the curet, and knows of instances in which a loop of gut has prolapsed through the opening so made.

When the ovum has been expelled intact, as in complete abortion, there is no necessity for further interference; and, as a rule, if the decidua vera is not cast off, it is not advisable to attempt its removal, as it is usually expelled spontaneously within a few days. At the same time, the physician should always satisfy himself by careful inspection that the entire ovum has come away, and that portions of it are not retained. For this reason, those in attendance on the patient should be instructed to preserve anything that may be passed in the absence of the physician, and not to follow the almost universal tendency to dispose of it at once; as careful inspection by a trained observer is required to recognize the component parts of the expelled ovum.

In incomplete abortion, on the other hand, the retained placenta and membranes should be removed promptly by the methods already described, and time should not be wasted in attempting to effect its expulsion by the use of pituitary extract. As soon as the uterus has been completely emptied, it contracts vigorously, and all danger of hemorrhage has passed. It sometimes happens that the physician does not see the patient until some days after the expulsion of the fœtus, when he is summoned on account of the persistent loss of blood, and upon examination finds that the cervix has become retracted to such a degree that it will not admit the finger. In this event, it can readily be sufficiently dilated by means of a Goodell dilator to permit the introduction of a finger, after which the remnants of the ovum are removed.

In many cases of criminally induced abortion, or in neglected cases, infection may occur. Symptoms may develop while the entire ovum is still in the uterus, during the course of an incomplete abortion, or after the completion of the entire process. The latter complication will be considered in the chapter upon Puerperal Infection. The two former conditions are always serious, and are responsible for the greater part of the deaths following abortion. The infection may be due to the usual pyogenic bacteria or to various so-called putrefactive types, and in hospital practice it is advisable to take an intra-uterine culture before undertaking any manipulation. The prognosis is always serious when the former bacteria are concerned, but is favorable when they are absent.

In view of the unsatisfactory results following infected abortion, Winter, in 1911, raised the question as to whether it would not be better in all streptococcus cases to defer interference until the acute symptoms had subsided. In 1923, after analyzing the results obtained by various authorities in the treatment of 24,000 such cases, he came to the conclusion that, unless the hemorrhage were alarming, it made little difference whether the uterus was evacuated early or late provided the infection is limited to it; but that when the process has advanced beyond it, much better results follow conservative treatment. Consequently, the first essential in an infected abortion is to determine by careful bimanual examination whether the uterus alone is involved, or whether the appendages and pelvic cavity are the seat of inflammatory lesions. In the first case, the uterus should be promptly emptied as described above; while in the second case no such attempt should be made until the fever has subsided, except in the presence of alarming hemorrhage. In the meantime, the patient should be kept in bed, fed abundantly, and the chief reliance placed upon cold applications to the lower abdomen.

With the exception of infected cases, the prognosis following abortion is excellent, provided a rigid technic is scrupulously observed. I have never had a death in an uninfected patient, and Young and Williams in a series of 1,331. cases, with an operative incidence of 87 per cent, record a mortality of only 0.07

per cent. In occasional neglected cases, the patient is brought to the hospital exsanguinated and in immediate danger of death. In such conditions it is important that treatment be directed toward the relief of the anemia rather than the local condition, and consequently a large transfusion of blood should precede any operative procedure.

The treatment of repeated abortion is in general so unsatisfactory as to constitute one of the opprobia of obstetrics. Unless some definite cause can be discovered and corrected by appropriate treatment, practically our only resource is to keep the patient in bed until the time of danger is well past. Blair Bell claims that he has obtained good results by the administration of corpus luteum extract, but in my experience it has not been efficient.

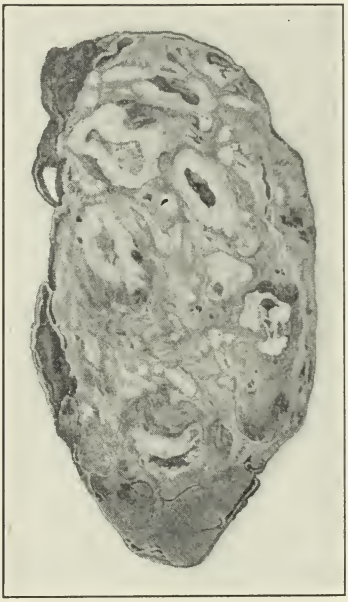

Fig. 549.—Missed Abortion. × 1. Product of conception expelled 13 months after last menstrual period.

Missed Abortion.—This term was applied by Oldham to the cases in which the fœtus is retained in the uterine cavity for months or years after its death. The condition occurs frequently in mares, cows, and sheep, but comparatively rarely in women. Seventy cases were collected from the literature by Graefe in 1896, and 105 by E. Fränkel in 1903, though I am convinced from my own experience that such figures give a very inadequate idea of its incidence, as I see several such cases each year.

Retention may exist for a long period without giving rise to symptoms, and such a possibility should always be borne in mind in the case of an abortion occurring in a woman who has been for some time separated from her husband, inasmuch as an error in this regard occasionally results in irreparable damage to her reputation. In other cases the patient may believe herself to be far advanced in pregnancy, and yet on examination the size of the uterus will be found to correspond to that of a much less advanced period. More frequently, however, the patient may present signs of threatened abortion, but after a varying period, the loss of blood and the pain disappear under appropriate treatment, so that there seems to be every prospect that the pregnancy will go to term. Some months later the physician will be consulted on account of the failure of the abdomen to enlarge, or because the breasts show regressive changes, when the uterus will be found to be smaller than it was at the time of the threatened abortion. In rare instances, when fœtal death has occurred very early in pregnancy, the enlargement of the uterus may be so slight as to escape recognition, and the condition may be regarded as one of essential amenorrhea. This happened in one of my patients, in whom the true state of affairs was not recognized until the small product of conception was expelled thirteen months after the last menstrual period (Fig. 549). Occasionally the condition, after persisting for months without symptoms, may exert an appreciable effect upon the patient, who may begin to lose flesh, suffer from a foul taste in her mouth, perhaps present a slight elevation of temperature, and occasionally symptoms of mental derangement.

According to Veit and Graefe, the retention is to be attributed to a lack of irritability on the part of the uterus, which does not contract as usual under the stimulation exerted by the dead ovum acting as a foreign body. In quite a number of cases the fœtus has been retained for more than one year, and in one instance for twenty-eight years. After expulsion the ovum frequently presents the characteristic structure of a hematoma mole; in other cases there are no manifestations of hemorrhage, and one has to deal with a so-called "dropsical ovum." In the case to which reference was made in the preceding paragraph, the ovum was represented by a small ovoid mass, covered by decidual tissue, and containing in its interior closely packed chorionic villi with well-preserved epithelium, but without a trace of a fœtus or amniotic cavity. In some of my specimens the villi have presented hydatidiform changes, and Düffel has stressed the significance of such an occurrence.

When the diagnosis is established beyond doubt, the treatment should vary according to circumstances. If the patient is suffering no inconvenience, it is my practice to defer interference in the hope that a spontaneous termination will occur in the near future. On the other hand, if she worries about her condition, and more particularly if symptoms appear, the cervix should be dilated or incised, and the uterus emptied of its contents. In several of my cases, the cervix was so firm that vaginal hysterotomy seemed the most conservative method for overcoming its resistance.

In very exceptional instances the entire product of conception may be absorbed without a sign of external discharge. Polano and L. Fraenkel have reported cases in which this occurred after the pregnancy had advanced as far as the fourth month, and it constitutes a well-recognized process in animals.

PREMATURE LABOR

By this is understood the spontaneous termination of pregnancy after the period of viability has been reached—twenty-eighth week—but before the child has attained maturity. For statistical purposes it is customary to designate as premature, children which weigh between 1500 and 2500 grams or measure between 35 and 45 centimeters in length.

The accident may be due to one of numerous factors, the most important being syphilis and continuous overwork during the later months of pregnancy. Less frequently, abnormalities of the product of conception, the various toxemias and chronic Bright's disease, lesions of the heart and lungs, as well as certain operations upon the generative tract, may be etiological factors. As is well known, marked degrees of hydramnios are frequently associated with premature labor, which is usually attributed to the excessive distention of the uterus. Placenta prævia also plays an important part, and it is generally recognized that the high fœtal mortality associated with the condition is attributable to the fact that it frequently leads to the premature termination of pregnancy. Abnormalities in the development of the fœtus, and more particularly the grosser forms of monstrosity, also lead to a similar result, but we are as yet unacquainted with the mechanism by which such conditions give rise to premature expulsive efforts. The various types of toxemia, particularly eclampsia and nephritic toxemia, frequently lead to premature labor. In the former, it is well known that the onset of convulsions is soon followed by uterine contractions, so that it is frequently difficult to determine whether one has to deal with ante- or intrapartum eclampsia. Nephritic toxemia often leads to the premature expulsion of a poorly nourished child or one which is already dead. Such a result may be due to the underlying maternal toxemia or to infarct formation in the placenta, which is sometimes so extensive as to interfere seriously with its nutritive function.

Many authors ascribe considerable etiological significance to valvular lesions of the heart, and believe that the death of the child and the premature uterine contractions are attributable to deficient oxygenation of the fœtal and maternal blood. From my experience, however, the importance of such lesions, as well as those of the lungs, appears to be exaggerated.

One of the most important causes of premature labor consists in certain operations which had been previously performed upon the cervix—the extensive repair of old lacerations and particularly high amputation. Each year I see several patients who had previously had one or more normal labors, but who, following such an operation, are unable to carry subsequent pregnancies to term. In such patients, gestation proceeds uneventfully until after the middle of pregnancy when premature labor sets in without apparent cause. In my experience prophylactic treatment is of no avail, as absolute rest in bed for months before the danger period fails to avert the accident, so that the woman seems doomed to repeated premature labor as long as the reproductive function persists. For this reason I consider that high amputation of the cervix is an extremely serious procedure from an obstetrical point of view, and consequently should be restricted to women who have already passed the menopause, except under the most pressing indications.

In the absence of any of the conditions enumerated, the birth of a living premature child may be regarded as an accidental occurrence, but the expulsion of a macerated child should arouse the strongest suspicion of syphilis, which should not be dismissed unless autopsy upon the child, microscopic examination of the placenta, and a Wassermann test upon the mother give negative results. Furthermore, a history of the repeated occurrence of premature labor should arouse a similar suspicion, and although it may be accounted for by chronic nephritis, operations upon the cervix, or even by unusual irritability of the uterus, it should lead to the most careful search for syphilis in both parents. In my experience the recognition and treatment of this disease is the most important matter in connection with the prophylaxis of premature labor, and until this teaching has permeated the rank and file of the profession, large numbers of children will continue to be sacrificed unnecessarily.

Some idea of the importance of syphilis may be gained from the fact that in a series of 334 premature labors, I found that it was the etiological factor in over 40 per cent, while toxemia, placenta prævia and fœtal deformity were concerned in 8, 6 and 3.3 per cent, respectively. Sentex, who studied 485 cases in Pinard's clinic, arrived at similar conclusions and found the underlying cause to be syphilis in 42.7, albuminuria in 19.8, and abnormalities of the fœtus in 11.1 per cent.

The figures of Holland, based upon the careful study of 300 fœtal deaths occurring in London at the time of labor, justify somewhat similar conclusions, and at the same time indicate what may be accomplished by proper prenatal supervision and by intelligent care at the time of labor. The percentage incidence of the several causes of death was as follows: Complications of labor 51, syphilis 16, cause undetermined 11, toxemia 10, relative placental insufficiency 6, fœtal deformity 5, and chronic renal disease 2 per cent. He holds that 52 per cent of these deaths could have been prevented—20 per cent by prenatal care alone, 12 per cent by combined prenatal and intranatal care, and 20 per cent by intranatal care alone. In other words, all of the deaths from syphilis and three-fifths of those from toxemia and complications of labor could have been avoided—an impressive arraignment of current obstetrical practice.

The course of premature labor differs but little from that of labor at full term, except that occasionally the entire product of conception is expelled *en masse*. In other instances, the onset of the accident is marked by premature rupture of the membranes and the escape of the amniotic fluid. The treatment is identical with that of full-term labor, except that when the patient is seen at the beginning of uterine contractions the accident may occasionally be averted by the administration of a powerful sedative and absolute rest in bed. The important point, however, is to make every effort to ascertain the cause of the accident, so that suitable prophylactic measures may be employed to prevent its recurrence.

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CHAPTER XXX

EXTRA-UTERINE PREGNANCY

In *extra-uterine pregnancy* the fertilized ovum is arrested at some point between the ovary and the uterus, and there undergoes more or less complete development. *Ectopic gestation,* which is sometimes used as a synonymous term, has a broader meaning, inasmuch as it includes not only the usual forms of extra-uterine pregnancy, but also those in which the ovum is implanted in the interstitial portion of the tube, in the rudimentary horn of a bicornuate uterus, or in a crypt far removed from the uterine cavity in a uterus presenting adenomyomatous changes, as described by Döderlein and Herrgott.

For a long time extra-uterine pregnancy was of interest chiefly from a pathological point of view, but since 1883, when Tait first operated upon a case of ruptured tubal pregnancy, the subject has attained a markedly practical interest, as is manifested by the immense literature of recent years. This history of its development is treated in detail in the monographs of Campbell, Hecker, Parry, Tait, Werth, and Webster.

Prior to 1876, extra-uterine pregnancy was considered so rare an affection that Henning stated that even the directors of large obstetrical institutions might never encounter a case, and Parry was able to collect only 500 instances from the entire literature. It was only with gradual development of abdominal surgery that its relative frequency became recognized and it is now generally admitted that operations for extra-uterine pregnancy constitute a definite percentage of all gynecological laparotomies. Thus, Wynne reports that in 22,688 patients admitted to the gynecological department of the Johns Hopkins Hospital prior to 1922, the incidence was 1.3 per cent.

Schumann calculated that the condition occurred once in every 303 pregnancies in Philadelphia during the year 1918. He arrived at this conclusion by obtaining statements from the various hospitals and operators as to the number of cases cared for, and compared the total thus obtained with the number of births recorded by the Health Department.

Classification.—As the fertilized ovum may be arrested at any point on its way from the graafian follicle to the uterine cavity, it may undergo development in the ovary or in any portion of the tube, giving rise to ovarian or tubal pregnancy, respectively. It is doubtful whether the ovum can become implanted primarily upon the peritoneum and, consequently, all reports of primary abdominal pregnancy should be viewed with skepticism.

Etiology.—According to Leopold, ovarian pregnancy results from the fertilization of the ovum before its escape from the graafian follicle. Moreover, he believed, when several follicles mature at the same time, that a deeply lying one may rupture into a more superficial one without the escape of its ovum, in which event the latter may be fertilized by spermatozoa entering through the superficial follicle. Such an occurrence would afford a satisfactory explanation for a pregnancy occupying the central portion of the ovary.

Unfortunately, equally concise and definite statements cannot be made concerning the etiology of tubal pregnancy, although a number of explanations, of greater or less plausibility, have been advanced. Broadly speaking, these may be divided into three main groups: (1) Conditions which interfere mechanically with the downward passage of the ovum; (2) inflammatory diseases of the tubes; (3) physical and developmental abnormalities which favor decidual formation in the tubes.

I. *Conditions which Interfere Mechanically with the Downward Passage of the Ovum.*—(*a*) Fritze, in 1779, first directed attention to the fact that peritoneal adhesions, by compressing the lumen of the tube or by interfering with its peristalsis, might cause the arrest of the ovum.

(b) Leopold, Breslau, Beck, Wyder, and others believed that polypi projecting into the lumen of the tube might occasionally interfere with the descent of the ovum. It is more probable, however, that such structures are not primary, but had appeared only after conception.

(*c*) Some observers believe that myomata, or other tumors, situated in the wall of the tube or in adjacent organs, may so compress the tubal lumen as to interfere with the passage of the ovum.

(*d*) Schroeder, in 1887, but more particularly Tait, a few years later, advanced the theory that the most frequent etiological factor was an endosalpingitis. This they supposed led to the destruction of the cilia and to the consequent cessation of the downward current, thereby allowing spermatozoa to enter the tube.

This view implied that fertilization normally occurs in the uterine cavity, and was based upon the supposition that the ciliary current was directed downward in the tubes and from below upward in the uterus, thereby facilitating the entry of spermatozoa into the uterine cavity, while rendering more difficult their access to the tubes.

After Hofmeier and Mandl had demonstrated the fallacy of these suppositions by showing that the current extends downward from the fimbriated extremity of the tube to the internal os, it became evident that the spermatozoa are obliged to contend against it from the time they enter the uterus. As it is now known that fertilization occurs normally in the tubes, the problem to be solved in every case of tubal pregnancy is not how the spermatozoa may have gained access to the tube, but why the fertilized ovum failed to make its way to the uterus.

Furthermore, the cilia may persist in spite of acute inflammation, and I have been able to demonstrate their presence in nearly every pregnant tube which I have examined, while Zedel saw them in motion in several specimens which he examined in the fresh condition.

(*e*) Abel, Kreisch, and others believe that the fœtal convolutions of the tube occasionally persist in later life, and hinder the downward passage of the fertilized ovum either by constricting the lumen or by interfering with peristalsis.

(*f*) In 1891, Landau and Rheinstein, and I demonstrated the presence of *diverticula* from the lumen of the tube, and suggested that a fertilized ovum entering such a structure would eventually be arrested at its blind end, where it might undergo further development (Fig. 550). Specimens, in which the fœtal sac lay entirely outside of the lumen of the tube, being separated from it by a layer of tissue of varying thickness (see Fig. 556), apparently offered confirmatory evidence of such an occurrence. When, however, Spee's teachings had become generally accepted that the ovum immediately burrowed into the depths of the mucosa, instead of being implanted upon its surface, as was formerly believed, it became apparent that the presence of the product of conception in the wall of the tube did not necessarily prove that it had been implanted in a diverticulum. Consequently, the value of such observations became considerably impaired. More recently, however, Schoenholz and McNally have insisted upon the etiological significance of such diverticula.

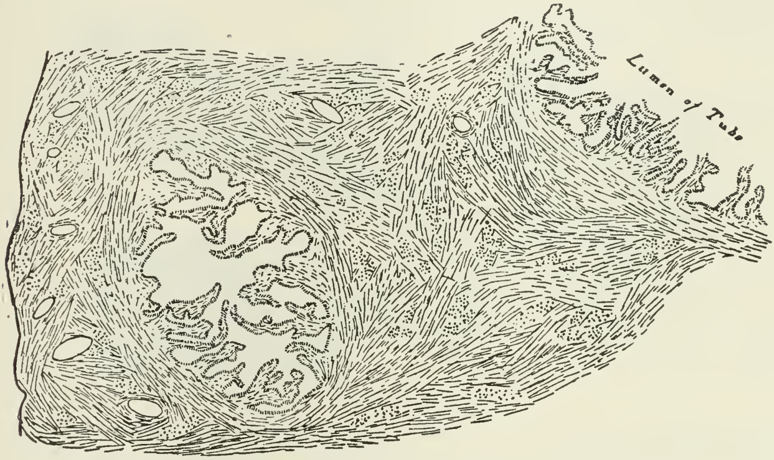

Fig. 550.—Diverticulum from the Lumen of Tube.

Now and again, in serial sections through the tube, it is possible to demonstrate the presence of accessory lumina—long processes, which extend from the main lumen and, after continuing parallel to it for a considerable distance, rejoin it, or end blindly. In several instances, I have noted conditions which seemed to indicate that the fertilized ovum had been arrested in such a structure.

Sometimes accessory ostia, instead of communicating with the lumen of the tube, represent mere culsdesac. That the fertilized ovum may be arrested in such a structure and go on to further development was conclusively demonstrated by Henrotin, Herzog, and Walthard (Fig. 551).

(*g*) Dührssen believed that in occasional instances the arrest of the ovum may be due to puerperal atrophy of the tube, whereby its normal peristalsis remains permanently impaired. Hoehne contends that general hypoplasia of the tube may have a similar effect.

(*h*) In a considerable number of cases which I have examined, the corpus luteum was situated not in the ovary corresponding to the pregnant tube, but in the opposite one, indicating that *external migration* had occurred, and that the fertilized ovum had made the transit of the pelvic cavity. Sippel believed that such a phenomenon may favor the production of extra-uterine pregnancy, since the fertilized ovum may attain such proportions during its migration as to interfere with its passage through the tube.

II. *Conditions Resulting from Inflammatory Conditions of the Tubes.*—As has already been said, Schroeder and Tait emphasized the etiological importance of such conditions. This view is supported by the fact that many cases of tubal pregnancy have been preceded by pelvic inflammatory trouble, and that a history of gonorrheal salpingitis can be elicited in a considerable proportion of the cases. After it had been demonstrated that the arrest of the ovum was not due to the destruction of the cilia by the inflammatory process, great difficulty was at first experienced in explaining the connection between the two conditions. In 1902, however, Opitz noted in many of his specimens that the tips of the folds of the mucosa had become fused together, so that the section presented the cribriform appearance characteristic of the so-called "follicular salpingitis." As similar lesions were also usually present in the nonpregnant tube, he held that they afforded a satisfactory explanation for the arrest of the ovum. He assumed that some of the canals inclosed between the adherent folds communicated freely with the main lumen of the tube, but ended blindly at the other extremity, so that if a fertilized ovum were arrested in such a culdesac a tubal pregnancy might develop.

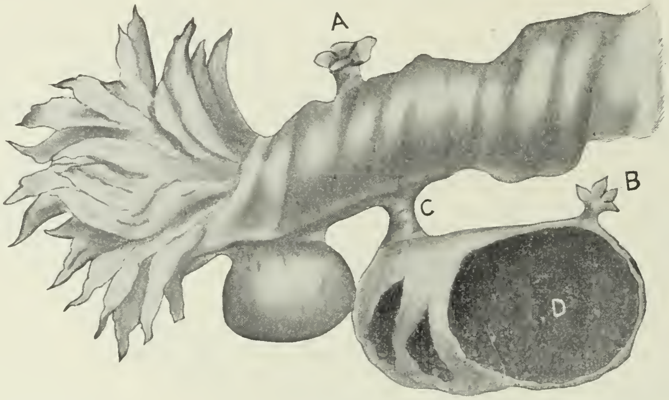

FIG. 551.—PREGNANCY IN ACCESSORY TUBAL OSTIUM (Henrotin and Herzog). *A,* small accessory ostium; *B,* opening of pregnant ostium; *C,* blind end of same; *D,* blood clot containing remnants of ovum.

This explanation was enthusiastically accepted by Werth and Hoehne, who considered it of almost universal application. I have frequently observed the same condition, and agree with Mall that it is an important etiological factor.

III. *Physical and Developmental Conditions which Favor Decidual Formation in the Tubes.*—Webster believed that the explanation for the comparatively infrequent occurrence of tubal pregnancy was to be found in the fact that the decidual reaction, which he considered essential to the proper implantation of the fertilized ovum, is usually lacking. He held that tubal pregnancy could develop only when the tubes are capable of this reaction. This he regards as a reversion to an earlier type, and therefore as a sign of degeneracy. This view was indorsed by Pantellani, Mandl and Schmidt, Wormser, Moericke, and others, but the belief is based upon theoretical considerations and is not supported by modern histological investigation.

From what has just been said, it is apparent that there is no lack of theories concerning the etiology of tubal pregnancy, and the question which we have to consider is which of them is correct, or whether any one is of universal application.

Tainturier, and Mandl and Schmidt approached the problem experimentally by applying ligatures to various portions of the generative tract of rabbits shortly after copulation. When applied to one uterine cornu some distance below the tubal opening, ova developed distal to the ligature, as well as in the normal horn, but when both cornua were ligated no ova developed median to the ligatures. On the other hand, when the ligatures were applied to the uterine ends of the tubes, extrauterine pregnancy did not develop, although dead ova could be demonstrated above the ligatures. In a series of control experiments, when only one tube was ligated, the same result was obtained on that side, while the other uterine horn contained normal embryos.

These experiments show conclusively that in the rabbit, at least, some factor other than mere mechanical interference with the downward passage of the ovum is necessary to the production of tubal pregnancy, and this Mandl and Schmidt sought in a preliminary decidual reaction. The fact, however, that the decidual formation is never abundant in the pregnant tube, and is frequently altogether absent, would militate against such a view.

The only positive experimental work along these lines was reported by Nuck many years ago, but it is probably open to the objection that he did not distinguish carefully enough between the cornua and the tubes in the bicornuate uterus of the lower animals.

The idea that tubal pregnancy is a sign of degeneration or reversion, while extremely interesting, and to a certain extent borne out by facts, cannot be accepted as a universal solution of the problem; for in many instances the condition occurs in well developed women who live amid the best surroundings. Moreover, its great rarity in the lower animals also speaks against such a view. Bland Sutton states that in his large experience in the zoölogical gardens of London he has never met with tubal pregnancy in animals, and believes that all such cases recorded in the literature are due to confounding the uterine cornua with the tubes. This statement, however, is too radical, as Waldeyer has reported an undoubted case in an ape.

In view of the considerations just adduced, it is apparent that the etiology of tubal pregnancy is not a simple matter, and that there is no universal cause for all cases. In many instances, the arrest of the ovum in a crypt resulting from follicular salpingitis, or in a diverticulum, affords a satisfactory explanation; while the fact that the condition occurs much more frequently in urban than in rural districts speaks strongly in favor of its inflammatory origin, as the possibility of gonorrheal infection is much greater in the former. On the other hand, in a certain proportion of cases even the most careful clinical history and microscopical examination of the specimen will fail to reveal a tangible cause for the condition, which will still remain as great a problem to us as to our predecessors.

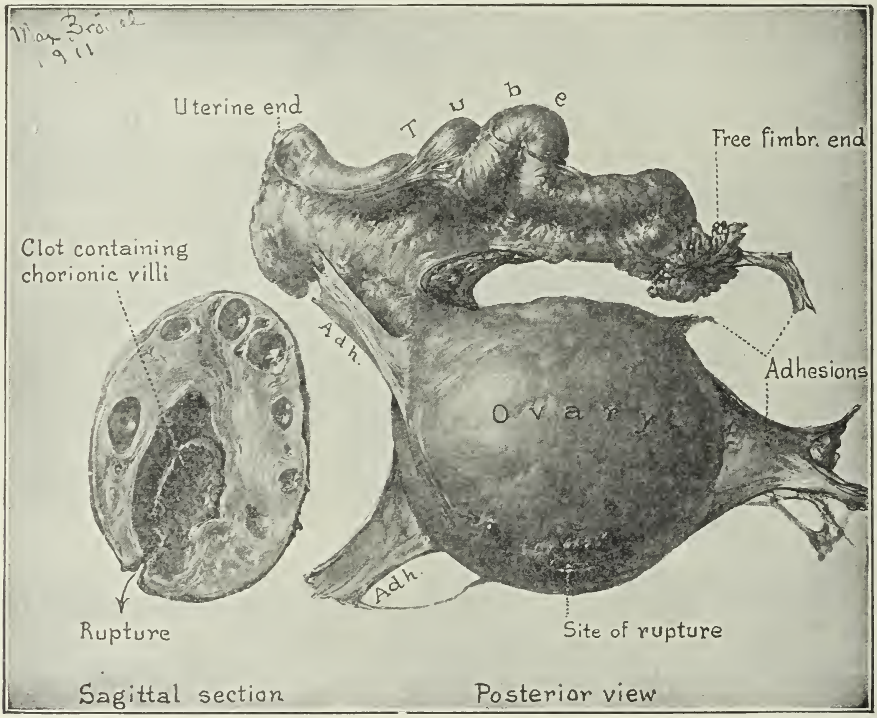
Max Brödel
1911
Uterine end
Tube
Free fimbr. end
Clot containing chorionic villi
Adh.
Adhesions
Ovary
Rupture
Adh.
Site of rupture
Sagittal section
Posterior view

FIG. 552.—E. K. CULLEN'S SPECIMEN OF OVARIAN PREGNANCY. × 1.

Ovarian pregnancy was first described in the seventeenth century by Mercerus and St. Meurice, and its possibility was generally conceded until 1835, when Velpeau stated that none of the cases which had been described up to that time afforded conclusive evidence of ovarian origin. Similar views were expressed by Mayer, in 1847, and were indorsed by Pouchet, Allan Thompson, and others. This skepticism was probably justifiable, since most of the early cases collected by Campbell and Gurgui were simply dermoid cysts of the ovary.

With the exception of Mayer, the possibility of ovarian pregnancy has always been admitted by the German writers, but was strenuously denied until 1901 by the English authorities, particularly by Tait, Webster, and Bland Sutton. In this country most writers have followed the English authorities, although Parry admitted its existence and not a few operators had reported doubtful cases; but it was not until 1902 that Thompson demonstrated a conclusive specimen.

Up to 1878, there existed no definite criteria by which specimens could be judged, and many were described as examples of ovarian pregnancy which had no claim to such a title. In that year, however, Spiegelberg formulated certain criteria which he held must be fulfilled in order to justify such a diagnosis. He demanded (1) that the tube on the affected side be intact; (2) that the fœtal sac occupy the position of the ovary; (3) that it be connected with the uterus by the ovarian ligament; and (4) that definite ovarian tissue be found in its wall. When judged by these criteria, the majority of cases which had been described up to his time were found wanting, and subsequent investigation has shown that a number of cases which he considered conclusive are likewise open to very considerable doubt.

Following the description of specimens of undoubted early ovarian pregnancy by Kouwer and Tussenbroek of Holland, in 1899, and by Thompson of this country, in 1902, the number of cases has gradually increased, so that Meyer and Wynne, in 1919, were able to collect 42 cases from the literature, and since then several additional authentic specimens have been dscribed each year. Consequently, the possibility of ovarian pregnancy is now universally admitted, but at the same time it is recognized that it occurs comparatively rarely. It is interesting to note that Webster, who originally held that it was theoretically impossible, has abandoned his skepticism, and has described two conclusive specimens.

It should also be mentioned that in a considerable number of the cases recorded the pregnancy had gone to full term, and in several instances had eventuated in the formation of lithopedia, which had been carried for years before being removed. This would appear to indicate that the ovary can accommodate itself more readily than the tube to the growing pregnancy. Full literature upon this aspect of the subject will be found in the article of Säntti (1928). At the same time it should be remembered that rupture at an early period is the usual termination. It is also important to bear in mind that the product of conception may undergo degenerative changes at any early period without rupture, and give rise to a tumor of varying size, consisting of a capsule of ovarian tissue inclosing a mass made up of blood and chorionic villi, which may or may not contain an amniotic cavity, as in the specimens of Mendes de Léon and Webster. Such observations render it probable that a certain proportion of ovarian hematomata may actually represent the remains of an early pregnancy, but such a diagnosis should not be considered unless microscopical examination reveals the presence of chorionic villi.

In ovarian pregnancy, the ovum itself and its mode of implantation do not differ eventually from that observed in the uterus, except that a definite decidual membrane is lacking, so that the fœtal ectoderm invades the ovarian stroma directly.

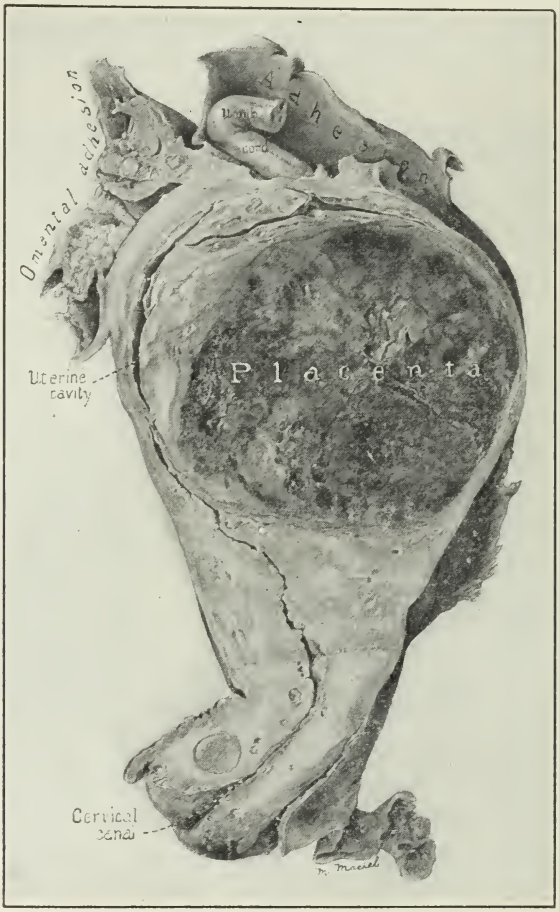

Fig. 553.—Interstitial Pregnancy. × ½.
Note placenta in posterior wall of uterus, and umbilical cord protruding through fundus. Rupture had occurred at the fourth month, and fœtus remained alive in the abdominal cavity until shortly before the death of the patient at the eighth month.

Tubal Pregnancy.—In this, by far the most frequent, variety of extra-uterine pregnancy, the ovum may develop in any one of the three portions of the tube, giving rise to interstitial, isthmic, or ampullar pregnancy respectively. In rare instances it may be implanted upon the fimbriated extremity, and occasionally even upon the fimbria ovarica. From these primary types certain secondary forms—tubo-abdominal, tubo-ovarian, and broad-ligament pregnancy—occasionally develop.

According to Rosenthal, the interstitial is the rarest variety, having occurred in only 3 per cent of the 1324 cases of tubal pregnancy which he collected from the literature. Lequeux was able to collect 75 cases up to 1911, which were still further increased by Wynne, in 1918. Of 146 personal cases analyzed by Hartmann and Bergeret, 119 were ampullar, 24 isthmic, and only 3 were interstitial. Most recent writers state that the ampullar variety is the commonest, and this has also been my experience.

Anatomical Considerations.—(*a*) Mode of Implantation of the Ovum.—Formerly it was taught that the implantation of the ovum, whether in the uterus or tube, was dependent upon the formation of a well-developed decidual membrane. The pioneer work of Graf Spee and Peters, however, has demonstrated that even in the uterus this is not necessary, as the ovum burrows down into the depths of an edematous endometrium, whose stroma cells have not yet assumed a characteristic decidual appearance. Modern views concerning the mode of implantation of the ovum in uterine pregnancy, apply equally well to the tube, although certain of its anatomical peculiarities usually necessitate a different outcome.

The ovum may become arrested in any portion of the tube, and, according to Werth, may become implanted in either one of two ways—columnar or intercolumnar. In the first, which is very rare, the ovum becomes attached to the tip or side of one of the folds of the mucosa; while in the second, implantation occurs at the peripheral portion of the lumen in a depression between two folds. In either event, the ovum does not remain upon the surface, but at once burrows through the epithelium, and comes to lie in the tissue just beneath it. At that time its periphery is made up of a capsule of rapidly proliferating trophoblast, whose cells soon invade the surrounding tissues. The invasive and arrosive properties of these ectodermal cells bring about degeneration of the muscle and connective-tissue cells, which eventually become converted into fibrin. At the same time maternal blood vessels are opened up, and the blood is poured out into spaces of varying size lying entirely within the trophoblast, or between it and the adjacent tissue. Young considers that edema and necrosis occur before the maternal tissue is reached by the fœtal cells, and are probably due to the action of chemical substances secreted by the latter.

In the usual, intercolumnar mode of implantation, owing to the absence of a submucosa and the absence of a decidual membrane in the tube, as soon as the ovum penetrates the epithelium it comes to lie in the muscular wall, and is separated from the lumen by a layer of tissue of varying thickness—the capsular membrane or pseudocapsularis (Fig. 556). On the other hand, in the rare columnar mode of implantation, the ovum lies in the interior of a fold of mucosa, and except at its base is surrounded on all sides by tubal epithelium, so that it has but slight space for expansion.

The further development of the pregnancy depends in great part upon the portion of the tube in which implantation has occurred. When in the ampulla, the growing ovum pushes forward the capsular membrane into the tubal lumen, so that the latter may eventually become so compressed as to appear as a mere crescentic slit. Later, if the course of the pregnancy be not interrupted, the capsular membrane may fuse with the neighboring mucosa, so that the lumen of the tube becomes obliterated in the immediate vicinity of the ovum.

On the other hand, when implantation occurs in the isthmus, and particularly in the portion immediately adjoining the uterus, the small size of the lumen precludes the possibility of such expansion. As a consequence the ovum distends the tube wall eccentrically, so that the lumen may eventually become completely separated from the underlying muscularis and be surrounded by fœtal tissue and villi, with the result that intraperitoneal rupture frequently occurs before the patient is aware that she is pregnant.

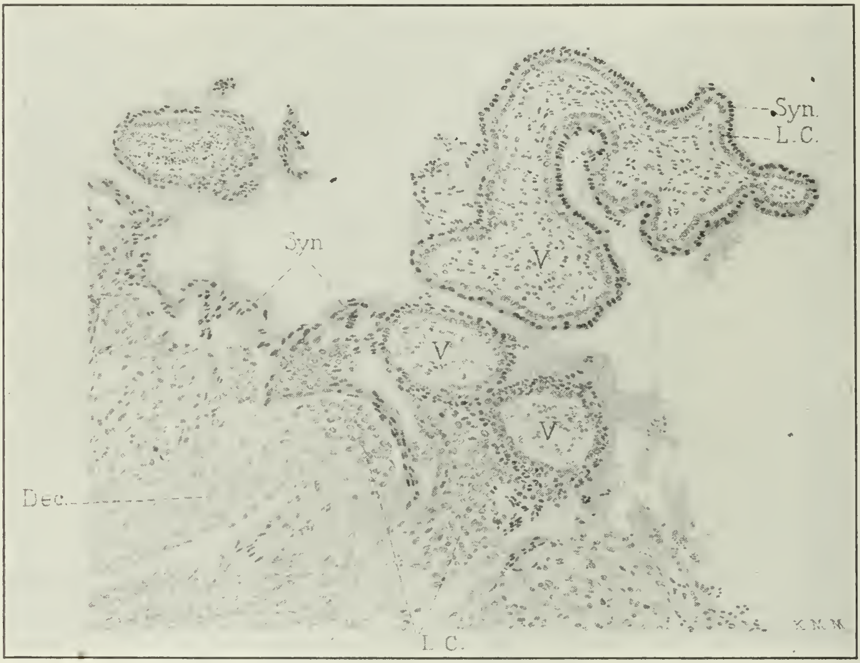

Fig. 554.—Section Showing Attachment of Chorion to Tube Wall. × 90. *Dec.*, decidual cells; *L. C.*, Langhans' cells; *Syn.*, syncytium; *V.*, villi.

(*b*) Decidua.—Bland Sutton, in 1891, and Füth and Griffiths a few years later, pointed out that the decidual reaction in the tube was nothing like so extensive as was generally believed; while Kühne, Aschoff, and Kreisch were even skeptical of its existence, and contended that the cells, which had formerly been described as decidual, were really of fœtal origin. The first mentioned view has been confirmed by subsequent observers, and at present no one claims that a continuous decidual membrane is formed.

On the other hand, it is erroneous to contend that a decidual reaction is always lacking, as it is possible by careful study to distinguish decidual cells, and to differentiate clearly between them and fœtal cells. The former are usually found in discrete patches in the tips of some of the folds of the musosa in the neighborhood of the ovum. Furthermore, one can occasionally find decidual cells scattered between the fœtal tissues at the placental site (Fig. 554), but I have never observed a continuous decidual membrane analogous to the decidua in uterine pregnancy.

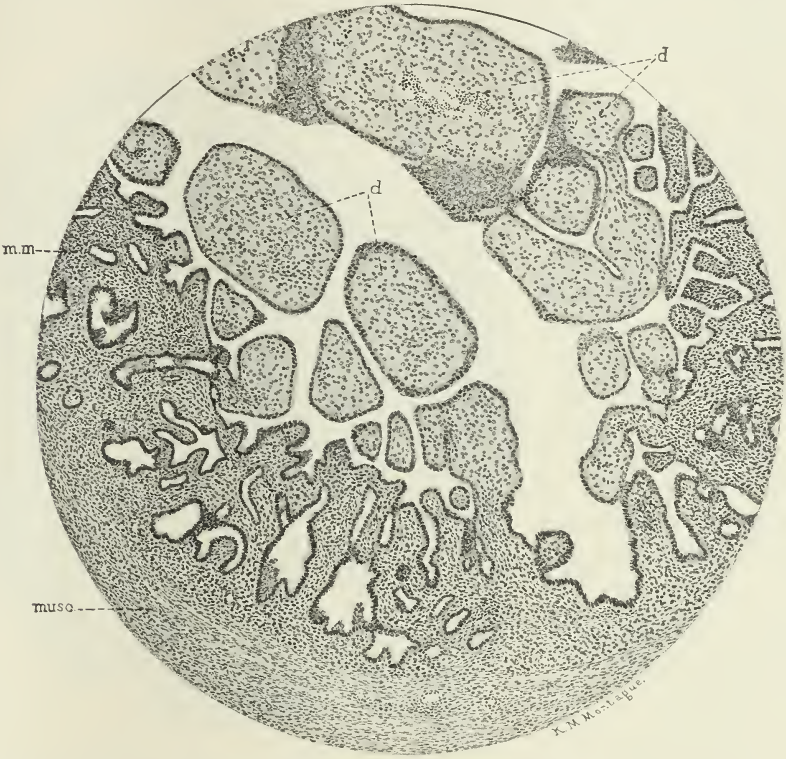

Fig. 555.—Section Showing Formation of Decidual Cells in Nonpregnant Tube, Demonstrating that They Could not Be of Fœtal Origin.
m.m., tubal mucosa; *musc.*, muscularis; *d.*, decidua.

That the authors who deny the existence of decidual cells in the tube take too extreme a view is shown by the fact that they have been repeatedly observed by Webster, Both, Couvelaire, Kermauner, Young, myself, and others. Moreover, the possibility of a decidual reaction is demonstrated by the fact that I have repeatedly observed characteristic decidual cells in the nonpregnant tube (Fig. 555). Observations of this character are beyond criticism, as in such cases it is impossible to confuse decidual with fœtal cells. Furthermore, Mandl, Lange, and I have noted an identical reaction in the tubes in certain cases of uterine pregnancy.

The absence, or comparative scantiness, of the decidual reaction is of interest not only from a scientific point of view, but also has a distinctly practical bearing, as it would seem to offer a satisfactory explanation for the invasion and destruction of the tube wall by the fœtal elements. In uterine pregnancy, such an invasion is noted only in the rare instances of placenta accreta, which is believed to result from defective development of the decidua. Consequently, it would appear that one of the main purposes of its formation is to protect the maternal tissues against the invasive and corrosive action of the fœtal cells.

(*c*) Decidua Capsularis.—Since the time of Rokitansky, the question as to the existence of a decidua capsularis in tubal pregnancy has been repeatedly discussed, one set of investigators claiming that it is usually present and the other set holding that it is always absent. The investigations of recent years have served to reconcile these differences.

In view of the general scantiness of the decidual reaction, it is evident that one could not reasonably expect the formation of a structure identical with the decidua capsularis of uterine pregnancy. On the other hand, in all intact early tubal pregnancies, the ovum is separated from the lumen of the tube by a thicker or thinner layer of connective and muscular tissue, which may contain a few isolated decidual cells (Fig. 556). As the pregnancy advances this membrane becomes invaded by fœtal cells, undergoes fibrinoid degeneration, and, if rupture does not occur, eventually fuses with the mucosa of the opposite side of the tube. As this structure is only superficially analogous to the decidua capsularis, it is better designated as the pseudocapsularis or capsular membrane.

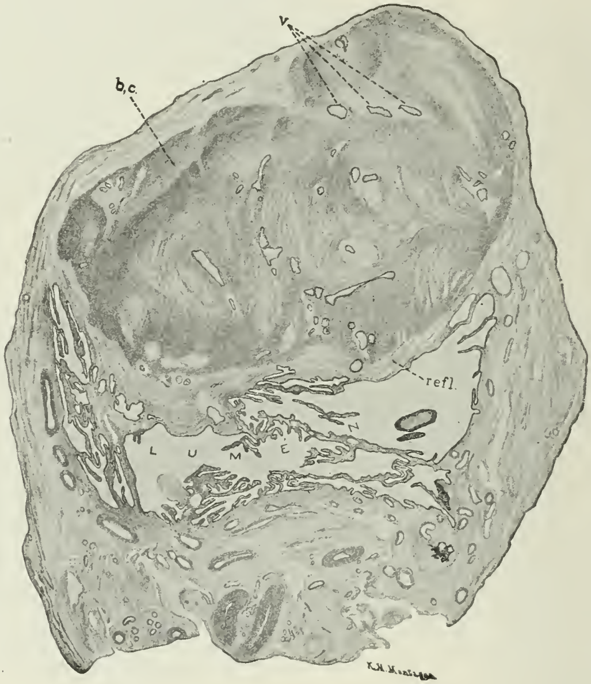

Fig. 556.—Early Tubal Pregnancy, Showing Ovum Embedded in Wall of Tube Outside of Lumen. × 6. *b.c.*, blood clot; *v.*, chorionic villi; *refl.*, capsular membrane.

(*d*) Placenta.—As the early stages of the development of the placenta are identical in both tubal and uterine pregnancy, the different outcome in the former is dependent upon the absence or scanty development of a decidual reaction. As a consequence, the tissues of the tube wall in contact with the ovum offer but slight resistance to the invasive properties of the fœtal elements, and soon undergo degenerative change. The chorionic villi and fœtal cells invade this tissue, almost like a malignant growth, and at the same time open up maternal blood vessels. In many cases they penetrate directly through the peritoneal surface or through the capsular membrane, and give rise to intraperitoneal rupture or tubal abortion, as the case may be. In other instances, however, early rupture is due to the sudden opening up of a large vessel, when the weakened tube walls yield to the increased pressure. Werth has quaintly expressed the process by stating that the ovum, in making its bed, digs its own grave.

The microscopic structure of the fœtal portion of the placenta is identical with that observed in uterine pregnancy. Even more frequently than in that condition, masses of Langhans' cells, syncytium, or even fragments of villi become broken off, and are carried by the veins to the general circulation. This process of deportation can be shown in almost every specimen by cutting serial sections. Moreover, Veit described as deportation the growth into venous channels of chorionic villi, which still retain their connection with the placenta, and believed that it plays an important part in the production of rupture, as such a clogging of the venous channels may so raise the pressure in the intervillous space that the weakened tube walls necessarily give way.

It is stated by Gubb and others that the placenta may continue to grow after the death of the fœtus. I, however, agree with Berry Hart, that it is improbable, except in the rare cases of hydatidiform mole formation; although it must be admitted that in advanced tubal pregnancy hemorrhage into the placenta may lead to a considerable increase in its size.

(*e*) Structure of the Fœtal Sac.—In tubal pregnancy there is a marked increase in the vascularity of the affected tube, the larger arteries and veins being much hypertrophied, while the smaller vessels, especially in the neighborhood of the placental site, are engorged.

Microscopical sections through the sac in the early months show a definite hypertrophy of the muscle cells, but no apparent increase in their number. Except at the placental site, the tube wall is considerably thickened, and its cells are spread apart by edema. At a still more advanced period, the muscular constituents of the gestation sac appear to diminish in number, so that at full term almost its entire thickness is made up of a connective tissue poor in cells, with only here and there a muscle fiber. This indicates that the muscularis of the tube has not the same tendency to hypertrophy as that of the uterus, though occasionally it is quite marked, Pinard having reported a case in which the fœtal sac contracted so strongly that he mistook it for a pregnant uterus.

In many advanced cases the exterior of the tube gives evidence of peritonitic involvement, and often a considerable portion of the thickness of the fœtal sac is due to peritoneal adhesions. Now and then, discrete patches of decidual formation result from the hypertrophy of the connective-tissue cells of such adhesions.

In order for complete tubal abortion to occur, the fimbriated extremity must remain patent, but in other cases its condition varies, being sometimes closed, sometimes open. As a rule, the lumen of the tube communicates directly with either end of the fœtal sac. Less commonly, however, this communication is noted only at the distal end, while still more rarely the fœtal sac is completely shut off from the main lumen. A satisfactory explanation of these differences has not yet been adduced.

(*f*) UTERINE CHANGES.—In the first three months the uterus undergoes considerable hypertrophy, and its endometrium becomes converted into a decidua vera just as in uterine pregnancy, and differing from it only in a less marked development of the spongy layer and a greater abundance of blood spaces just beneath its free surface. Careful study of its histological structure was reported by Sampson, in 1915. Soon after the death of the fœtus, the decidua degenerates and usually comes away in small pieces, but occasionally it is cast off intact, representing a triangular cast of the uterine cavity. Its discharge is considered of marked diagnostic significance; so much so that in the past, various writers recommended curetting the uterus in doubtful cases, and basing their diagnosis upon the presence or absence of decidual tissue. This, however, is a useless practice, as within a few weeks after the death of the product of conception the decidua will be displaced by normal endometrium. Failure to remember this physiological fact probably accounts for the statement of Moritz and Douglass that they were able to demonstrate a uterine decidua in only 8 out of 56 cases of tubal pregnancy.

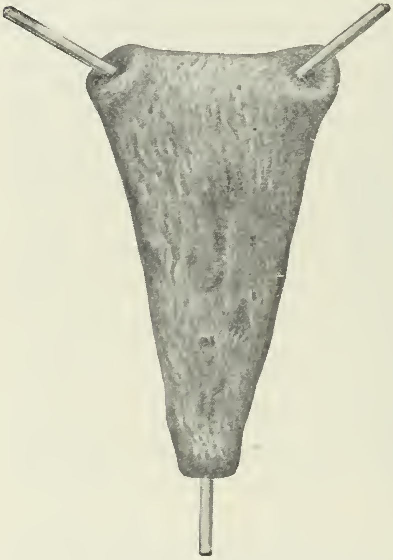

FIG. 557.—UTERINE DECIDUA FROM A CASE OF EXTRA-UTERINE PREGNANCY (Zweifel).

Terminations of Tubal Pregnancy.—According to Tait, the universal fate of tubal pregnancy was rupture either into the peritoneal cavity, or between the folds of the broad ligament, occurring not later than the twelfth week. Wider experience has demonstrated the incorrectness of his teachings, as more than one-half of the cases terminate at an early period by abortion after rupture through the capsular membrane. Very exceptionally, the pregnancy may go on to full term without rupture, as I have observed in several instances.

(*a*) TUBAL ABORTION (INTRATUBAL OF CAPSULAR RUPTURE).—After Werth, in 1887, had directed attention to the possibility of tubal abortion, it has gradually become established that this is the most frequent outcome of tubal pregnancy. The marked change of opinion which has taken place upon this point is readily appreciated by comparing the statements made by Schrenck and

Werth, in 1892 and 1904, respectively. The former found only 6 cases of abortion in 610 cases of tubal pregnancy collected from the literature; whereas the latter stated that 7 out of 8 cases ended in that way.

The frequency of tubal abortion depends in great part upon the site of implantation of the ovum. In ampullar pregnancy, it is the general rule, whereas intraperitoneal rupture is the usual outcome in isthmic pregnancy. This difference is due to the fact that in the former location the tubal lumen is sufficiently capacious to permit of a considerable degree of expansion of the fœtal sac, whereas in the latter the lumen is so small that this is impossible; and as expansion can occur only toward the periphery, early rupture is the usual termination.

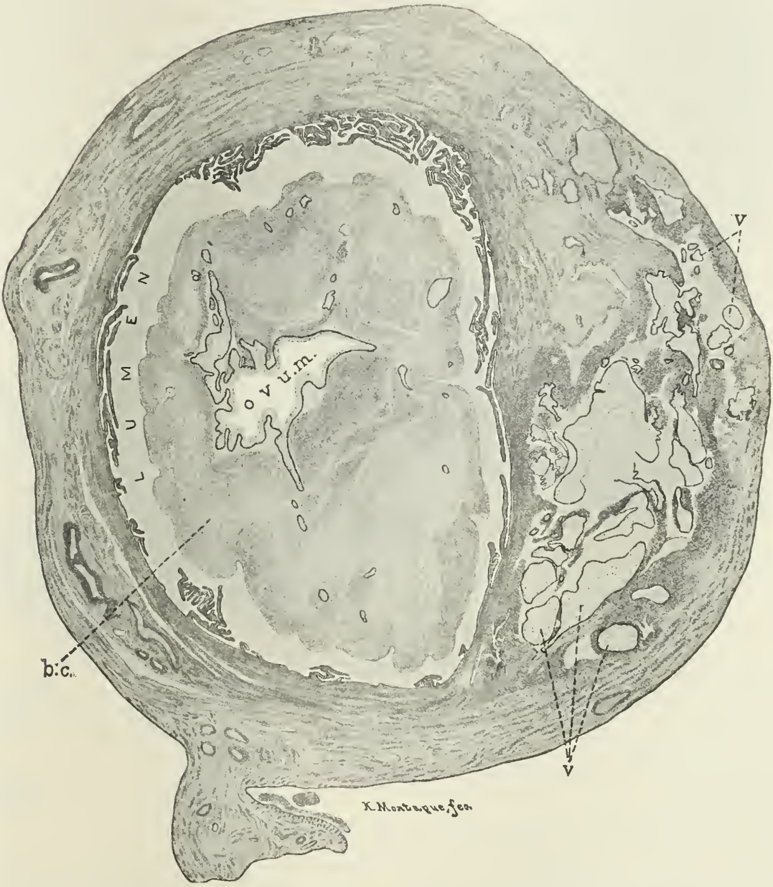

Fig. 558.—Early Tubal Pregnancy, with Abortion of Ovum into Lumen of Tube. × 6. *b.c.*, blood clot; *v.*, chorionic villi.

Tubal abortion results from the perforation or rupture of the capsular membrane or pseudoreflexa by the growing chorionic villi, and therefore does not differ essentially from intraperitoneal rupture, except in the fact that in one case the accompanying hemorrhage occurs into the lumen of the tube, whereas in the other it takes place into the peritoneal cavity. Accordingly, the term "tubal abortion" could be well replaced by that of intratubal rupture, as suggested by Berkeley and Bonney.

The immediate consequence of the hemorrhage is the loosening of the connection between the ovum and the tube wall, the former becoming completely or partially separated from its site of implantation. In the former case, the entire ovum is extruded into the lumen of the tube, and is gradually forced by the effused blood toward the fimbriated end, through which it may be extruded into the peritoneal cavity, whereupon the hemorrhage usually ceases. In the latter event, on the other hand, the ovum remains in situ, and the hemorrhage continues. Accordingly, we distinguish between *complete* and *incomplete tubal abortions,* the latter occurring ten times more frequently than the former, according to Wormser.

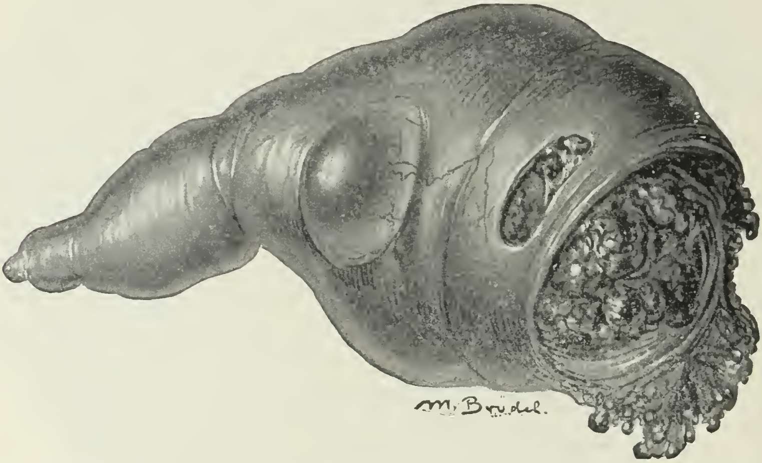

Fig. 559.—Tubal Abortion, Ovum Being Extruded through Fimbriated Extremity (Kelly). × 1.

In a small number of cases the ovum may be observed in the act of abortion (Fig. 559). Thus, among my own specimens are several which show the fœtus surrounded by its membranes, protruding from the dilated fimbriated extremity of the tube.

In incomplete tubal abortion, when the hemorrhage is moderate in amount, the ovum may become infiltrated with blood and becomes converted into a structure analogous to the blood or fleshy mole observed in uterine abortions (Fig. 560). Slight bleeding usually persists as long as the mole remains in the tube, and the blood slowly trickles from the fimbriated extremity into Douglas' cul-desac, where it becomes encapsulated, giving rise to an *hematocele.* If the fimbriated extremity is occluded, the tube may gradually become distended by blood—*hematosalpinx.*

After incomplete abortion, small particles of the chorion may remain attached to the tube wall and, becoming surrounded by fibrin, give rise to a placental polypus, just as is often noted after an incomplete uterine abortion.

(*b*) Rupture into the Peritoneal Cavity.—Less than one-half of the cases of tubal pregnancy end within the first twelve weeks by intraperitoneal rupture, which usually occurs spontaneously, but occasionally is the result of violence. Generally speaking, when rupture occurs in the first few weeks, the pregnancy is situated in the isthmic portion of the tube, a short distance from the cornu of the uterus (Fig. 561). On the other hand, when the ovum is implanted in the interstitial portion of the tube, rupture usually does not occur until after the fourth month, and sometimes considerably later. This difference is due to the fact that the interstitial portion of the tube is surrounded by a thick layer of uterine musculature, which reacts promptly to the stimulation of pregnancy, and by its hypertrophy allows the ovum to attain a considerable size before rupture occurs.

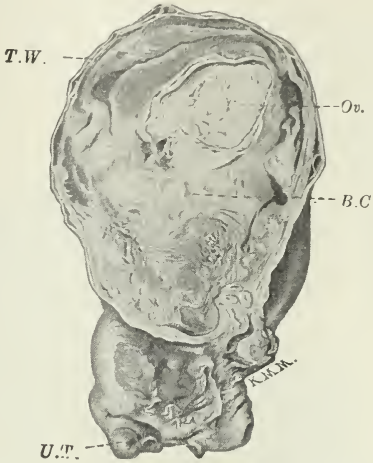

Fig. 560. — Section through Tubal Mole. × 1.
B.C., blood clot; *Ov.*, ovum; *T.W.*, tube wall; *U.T.*, uterine end of tube.

The prime factor in the causation of rupture is the intramural embedding of the ovum, and the consequent invasion of the tube wall by chorionic ectodermal elements, with consequent fibrinoid degeneration of the muscular layer. Its direct cause may be violence, such as vaginal examination, coitus, a fall, or even mere overexertion, though in the great majority of cases it occurs spontaneously. In the latter event, rupture is brought about either by direct perforation by the growing villi, or by the weakened tube wall yielding to a sudden increase of pressure in the intervillous spaces, following the sudden opening up of a large vessel or the clogging of venous channels by chorionic villi. The evidence available seems to indicate that the latter is the more usual factor.

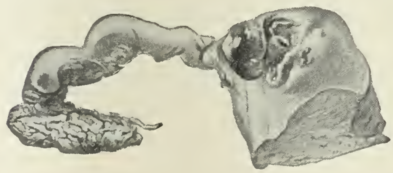

Fig. 561.—Isthmic Pregnancy, Rupture Ten Days after Last Menstrual Period. × 1.

If rupture occurs in this way in a tube with an approximately normal lumen, it is apparent that it will be likely to occur at a much earlier period if the ovum be arrested in a diverticulum from its lumen, as in that event it will have only a portion of the tube wall to penetrate, instead of its entire thickness.

Occasionally, when the fimbriated end of the tube is occluded, secondary rupture may occur after a primary abortion. In such circumstances the weakened tube wall yields to the pressure of the blood, which has been poured into its lumen and can find no other means of escape.

Rupture usually occurs in the neighborhood of the placental site, and either into the peritoneal cavity or between the folds of the broad ligament, depending upon the original site of the ovum. The terminations of the two conditions differ so markedly that it will be necessary to consider them separately.

In intraperitoneal rupture, the entire ovum may be extruded from the tube, but if the rent be small, profuse hemorrhage may occur without its escape. In either event, the patient immediately shows signs of collapse. If death from hemorrhage does not follow, the effect of rupture varies according to the amount of damage sustained by the ovum. If expelled intact into the peritoneal cavity, the death of the fœtus is inevitable; and unless the pregnancy has advanced beyond the third month, the product of conception will be rapidly absorbed, as was shown by Leopold's experiments upon animals.

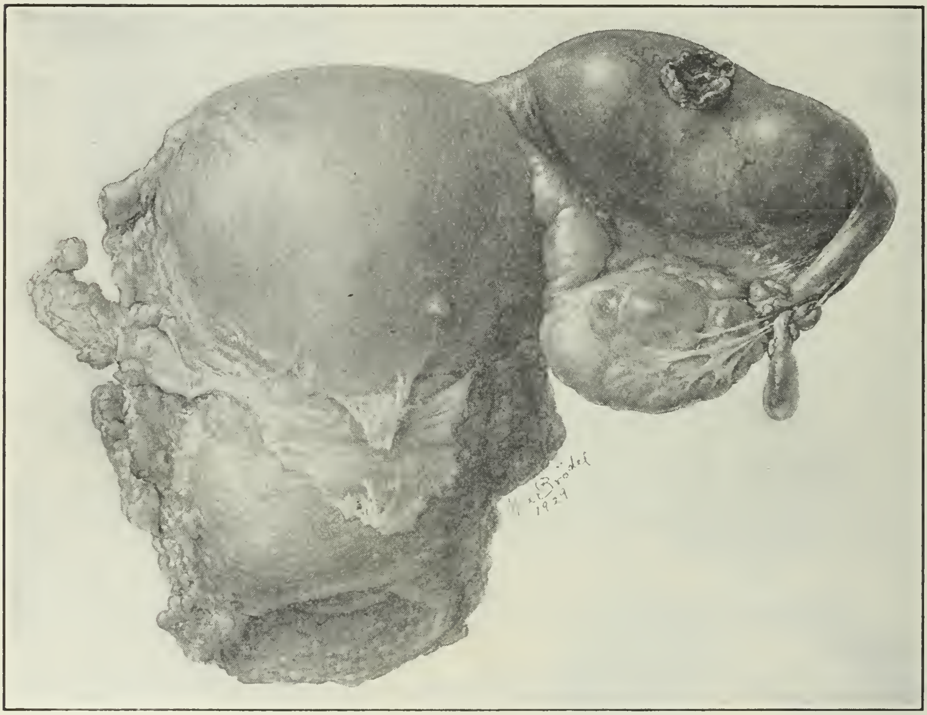

Fig. 562.—Ruptured Tubal Pregnancy. × ⅘.
Death from hemorrhage immediately after admission to hospital. Left appendages had been removed on account of tubal pregnancy several years previously.

It is still thought by many that in such circumstances the ovum may become reattached to any portion of the peritoneal cavity, and there establish vascular connections, which will render further development possible. I do not believe that this can occur, as it is improbable that such connections could be established before the ovum had become irreparably damaged, not to speak of the negative evidence afforded by Leopold's experiments.

On the other hand, if only the fœtus escapes at the time of rupture, the effect upon the pregnancy will vary according to the extent of injury sustained by the placenta. If much damaged, death of the fœtus and termination of the pregnancy are inevitable; but if the greater portion of the placenta still retains its attachment to the tube, further development is possible, and the fœtus may go on to full term, giving rise to a secondary abdominal pregnancy. In such cases, the tube may close down upon the placenta and form a sac, in which it remains during the rest of the pregnancy. Or, while a portion of the placenta remains attached to the tube wall, its growing periphery extends beyond it and establishes connections with the surrounding pelvic organs. In such circumstances the placenta may be attached partly to the uterus, pelvic floor, rectum, or even the intestines.

I do not believe, however, that the placenta can become solely and directly attached to organs far removed from the pelvic cavity, such as the stomach and diaphragm, for instance; and when such connections are observed, I consider that one has to deal with a broad-ligament pregnancy, which had become adherent to the organ in question, and that the placenta will be found to be attached to the inner surface of the fœtal sac adjacent to the adhesion.

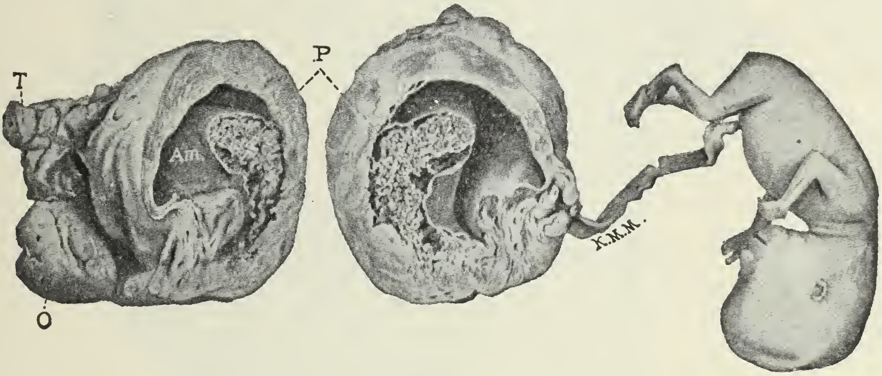

Fig. 563.—Ruptured Ampullar Pregnancy. × 1.
Am., amnion; *O.*, ovary; *P.*, placenta; *T.*, uterine end of tube.

When the fœtus escapes from the tube, following rupture, it is nearly always surrounded by its membranes, and most authorities believe that further growth is impossible, unless it is enclosed within the amnion, although several cases have been reported in which a full-term fœtus lay perfectly free in the peritoneal cavity, and all that was left of its membranes was found in the tubal sac.

(*c*) Rupture into the Broad Ligament.—In a small number of cases, especially when the original insertion of the ovum was basiotropic, as Lichtenstein designates it, rupture may occur at the portion of the tube uncovered by peritoneum, so that the contents of the gestation sac are extruded into a space formed by the separation of the folds of the broad ligament. Generally speaking, this is the most favorable variety of rupture, and may terminate either by the death of the ovum and the formation of a *broad-ligament hematoma*, or by the further development of the pregnancy.

The outcome depends largely upon the degree of completeness with which the placenta has been separated. If it still remains attached to the interior of the tube, it generally becomes displaced upward as pregnancy advances, and comes to lie above the fœtus; but when it is situated near the point of rupture it gradually extends down between the folds of the broad ligament, being implanted partly upon the interior of the tube and partly upon the pelvic connective tissue. In either event, the fœtal sac lies entirely outside of the peritoneal cavity, and as it increases in size the peritoneum is gradually dissected up from the pelvic and abdominal walls. This condition is designated as *extraperitoneal* or *broad-ligament pregnancy,* and was carefully studied by Dezeimeris as early as 1836. Occasionally, the broad-ligament sac may rupture at a later period, and the child be extruded into the peritoneal cavity, while the placenta retains its original position—*secondary abdominal pregnancy.*

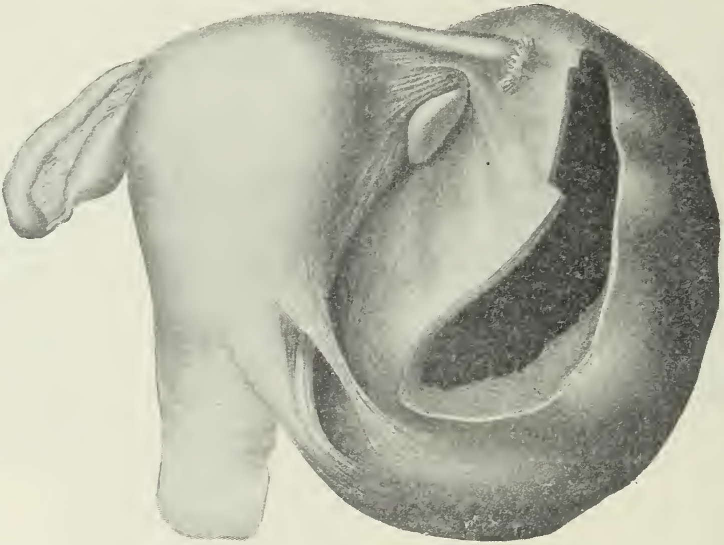

FIG. 564.—BROAD-LIGAMENT PREGNANCY (Zweifel).

The importance of rupture into the broad ligament was particularly emphasized by Tait, who believed that it was only under such circumstances that extra-uterine pregnancy could go on to full term. But since a certain number of cases of tubal pregnancy go on to term without rupture of any kind, it is evident that his statements were based upon imperfect information. The frequency of this mode of rupture has been considerably overestimated, as it was noted in only 4 out of 276 cases collected from the articles of Mandl and Schmidt, Küstner, and Fehling.

The so-called *tubo-uterine pregnancy* results from the gradual extension into the uterine cavity of an ovum which was originally implanted in the interstitial portion of the tube. *Tubo-abdominal pregnancy,* on the other hand, is derived from a tubal pregnancy in which the ovum has been inserted in the neighborhood of the fimbriated extremity, and gradually extends into the peritoneal cavity. In such circumstances, the portion of the fœtal sac projecting into the peritoneal cavity forms adhesions with the surrounding organs, which often seriously complicate its removal at operation. Neither of these conditions is common, nor do they deserve to be classified separately; in reality, they are merely pregnancies developing at unusual portions of the tubes.

The term *tubo-ovarian pregnancy* is employed when the fœtal sac is composed partly of tubal and partly of ovarian tissue. Such cases owe their origin to the development of an ovum in a tubo-ovarian cyst, or in a tube whose fimbriated extremity was adherent to the ovary at the time of fertilization. They are therefore primarily either tubal or ovarian in origin.

Abdominal Pregnancy.—In the earlier literature it was generally stated that the ovum could be implanted upon any portion of the peritoneum, giving rise to a primary abdominal pregnancy, and in Hecker's statistics it was recorded twice as frequently as the tubal variety. Later, however, when the specimens were more carefully studied, it became apparent that the great majority of abdominal pregnancies were secondary in character, having resulted from ruptured tubal pregnancy.

Gradually doubt began to be cast upon the existence of primary abdominal pregnancy, so that at present most authors, while admitting its theoretical possibility, are extremely skeptical as to its actual occurrence. Bland Sutton positively denies its occurrence in women, and contends that it is not observed in the lower animals. Hirst and Knipe, Walker, and Jacquin have, however, described specimens, which nearly fulfill the requisite criteria, while Reifferscheid has described a six-weeks' pregnancy implanted upon the mesentery of the sigmoid flexure, which appears to be beyond criticism.

Occasionally, as was shown by Zweifel, Leopold, Werth and others, the fertilized ovum may become implanted upon the fimbria ovarica. Such conditions may closely resemble primary abdominal pregnancy, inasmuch as the surface upon which the ovum was primarily implanted is so small that the margins of the placenta soon extend beyond it and become attached to the surrounding organs, thus giving the impression that the peritoneum was the original site of implantation. A careful microscopical examination, however, will usually enable one to differentiate between the two conditions.

Fate of Extra-uterine Fœtus.—In the rare instances in which an unruptured tubal pregnancy goes to term, the fœtus usually presents some abnormality, which is often attributable to pressure. On the other hand, absorption is the universal fate of small embryos which are extruded into the peritoneal cavity, unless the placenta retains its attachment to the tube wall and still offers conditions suitable for the continuance of the circulation. Moreover, the embryo is frequently absorbed while still within the tube, as is shown by the fact that it is sometimes represented by an amorphous mass of tissue attached to the umbilical cord. At times the only indication of its previous existence is found in a small stub of cord hanging free in the amniotic cavity.

Mall, who has directed particular attention to the condition of the fœtus while still within the tube, believes that it is particularly prone to abnormal development. In 117 specimens he found only 16 normal embryos, and, he calculated that in all probability not more than 1 per cent of all extra-uterine pregnancies will reach full term. Furthermore, when the fœtus has attained a certain size before death it cannot be absorbed, and must eventually partake in one of the following outcomes—suppuration, mummification, calcification, or adipocere transformation. Pyogenic bacteria often gain access to a gestation sac, particularly when it is adherent to the intestines, and give rise to *suppuration* of its contents. Eventually the abscess perforates at the point of least resistance, and if the patient does not die from septicemia, portions of the fœtus may be extruded through the abdominal wall or into the intestines or bladder, according to the situation of the perforation. This outcome is particularly frequent in broad-ligament pregnancies, on account of their proximity to the rectum.

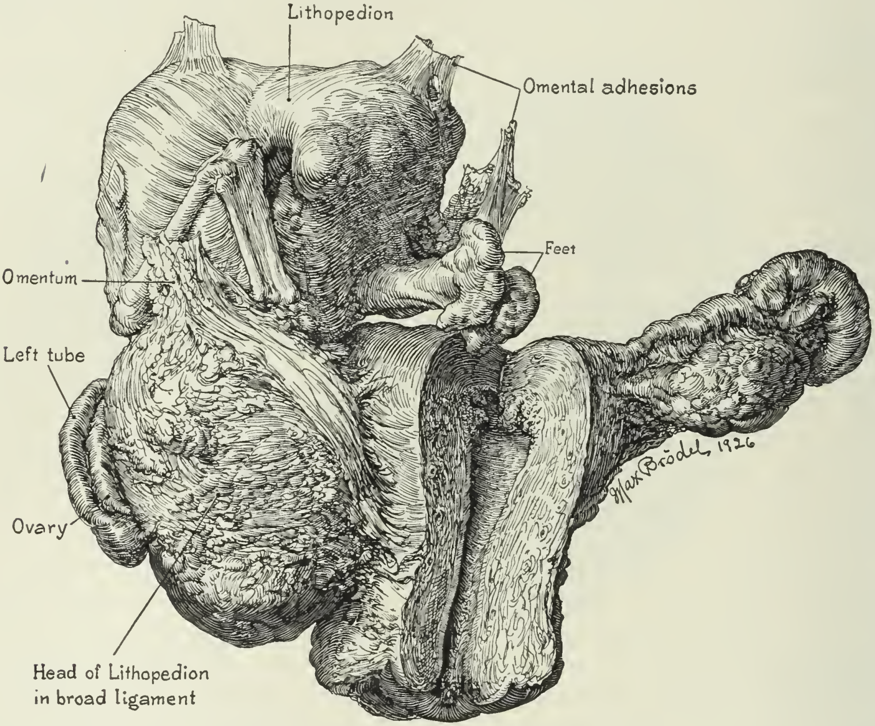

Fig. 565.—Lithopedion, Rear View. × ⅔.
Left sided broad-ligament pregnancy. Obtained at autopsy 40 years later.

Mummification and *lithopedion formation* have already been referred to in the chapter on Abortion, and are dealt with fully in Küchenmeister's article. The latter is generally regarded as the most favorable of the possible eventualities in cases of advanced extra-uterine pregnancy, as in many instances the calcified product of conception may be carried for years as a benign foreign body, and do no harm unless it gives rise to dystocia in a subsequent pregnancy. In several instances a lithopedion has been known to remain in the abdomen for fifty years, and the literature contains numerous cases in which a period of twenty to thirty years elapsed before its removal at operation or autopsy.

Much more rarely the fœtus may become converted into a yellowish greasy mass to which the term *adipocere* is applied. The fatty material is supposed to be an ammoniacal soap, but a satisfactory explanation of its formation has not as yet been advanced.

Diseases of Extra-uterine Ovum.—If an extra-uterine pregnancy goes on without interruption beyond the first few weeks, the ovum is exposed to all the diseases which may occur in the ordinary uterine form. Thus, Schauta, Wertheim, and Micholitsch have described tubal ova which had become converted into hematoma moles. Hydatidiform moles have been observed by Otto, Recklinghausen, Wenzel, Sykow, and others; and hydramnios by Teuffel, Webster, and others. Meyer's statement that he found hydatidiform-mole formation in 48 out of 104 pathologic tubal pregnancies cannot be accepted without question. In my opinion, he has described as such the myxomatous degeneration of the stroma of the chorionic villi, which so often occurs in degenerating pregnancies, and failed to recognize that proliferation of the chorionic ectoderm is the characteristic feature of hydatidiform mole. Reference has already been made to the fact that chorionepithelioma may develop from extra-uterine pregnancy. It is interesting to note that Spiegelberg and Holst observed the occurrence of eclampsia during the false labor in cases of advanced extra-uterine pregnancy.

Symptoms.—Unfortunately, the manifestations belonging to an uninterrupted extra-uterine pregnancy are not characteristic, and the patient and her physician are frequently unaware of the existence of any abnormality until death of the fœtus, rupture, or tubal abortion occurs. Ordinarily the patient considers herself pregnant, presents the usual subjective symptoms, and possibly suffers from slight pains in one or other ovarian region, which she regards as the usual concomitants of her condition. In rare instances, indeed, she may have no idea that she is pregnant, and rupture may occur and perhaps prove fatal, even before she has missed a single menstrual period.

Suppression of the menses is not associated so regularly with this condition as with normal pregnancy, being noted in only one-half of Brady's cases. These statements, however, do not carry as much weight as would appear at first sight, for frequently the hemorrhage does not represent a genuine menstrual flow, but is due to the fact that the dilated vessels in the uterine decidua are not covered by a layer of fœtal tissue. Moreover, the death of the extra-uterine fœtus, if not accompanied by rupture or abortion, is usually associated with more or less uterine bleeding, which is frequently mistaken for the menstrual flow or for an early abortion, the latter belief being still further confirmed by the discharge of decidua.

In many cases the first manifestation of the abnormal pregnancy is the sudden occurrence of intense, lancinating pain in one or other ovarian region, which is soon followed by faintness, the patient rapidly passing into a condition of collapse. This indicates the occurrence of rupture or abortion. In the former case the collapse deepens, the face becomes pallid, and the patient complains of intense pain in the lower abdomen. The temperature may be subnormal, and an examination of the blood shows a marked diminution in the amount of hemoglobin. Death may occur within a few hours unless the hemorrhage is checked by operative means. On the other hand, in most cases of tubal abortion, the general condition is not so alarming, the patient rallies promptly, gradual recovery ensues, and a few days later vaginal examination frequently reveals the presence of a fluctuant mass which fills a greater or lesser portion of the pelvic cavity—*pelvic hematocele.*

Formerly, hematocele was considered as a distinct disease, and it was mainly owing to Veit's observations that its connection with extra-uterine pregnancy was established. It is described as *diffuse* or *solitary,* according as the collection of blood occupies a considerable portion of the pelvic cavity or is confined to the neighborhood of the fimbriated end of the tube. The diffuse variety usually occurs when preëxisting adhesions about the pelvic organs facilitate the coagulation of blood and aid in the formation of an organized membrane over it, thus shutting it off from the peritoneal cavity. According to Sänger, the solitary hematocele does not require the presence of adhesions for its formation, but results from the gradual trickling of blood from the fimbriated end of the tube, the outer portions gradually coagulating and becoming organized, thus forming a capsule which slowly expands as more blood escapes.

Hematocele formation, for the most part, promises a very favorable termination, for if left alone the mass gradually undergoes absorption and complete recovery occurs. Thorn has reported 157 cases with two fatalities, and Fehling 91 cases without a single death. Occasionally, however, if the hemorrhage persists, the hematocele increases in size until it finally ruptures and its contents are poured out into the peritoneal cavity. Such an accident is speedily followed by collapse. Again, bacteria sometimes make their way into the mass from the intestines and cause suppuration.

If the patient survives the rupture of a tubal pregnancy, and the placenta has not been separated to too great an extent, a *secondary abdominal pregnancy* may result. In such circumstances the usual symptoms of pregnancy persist, except that the woman suffers more pain and feels the fœtal movements more acutely than usual. The pain is due partly to stretching and possibly to contractions of the fœtal sac, but principally to traction upon adhesions which have formed between it and the various abdominal organs.

In a small number of cases in which the primary rupture has taken place between the folds of the broad ligament, *secondary rupture* into the peritoneal cavity may occur at a later period, and the patient may bleed to death, or a secondary abdominal pregnancy may result. In the latter event, the fœtus lies within the peritoneal cavity, while the placenta remains partly within the tube and partly between the folds of the broad ligament.

If a secondary abdominal pregnancy, or, as now and again occurs, an unruptured tubal pregnancy, goes on to term, *false labor* sets in, associated with pains similar to those occurring in the early stages of normal labor. These are due to uterine contractions, since the fœtal sac contains so few muscular fibers that it cannot contract, and of course cannot lead to the birth of an extra-uterine child. This false labor may last for some hours or several days, and is soon followed by the death of the child, although in a small number of cases the fœtal movements have been known to persist for a considerable time after the cessation of the pains.

After the death of the fœtus, the placental circulation gradually becomes abolished, the amniotic fluid is absorbed, and the fœtal sac retracts, so that it occupies a much smaller space than formerly. The abdomen consequently becomes smaller, and its change in size is soon noticed by the patient. After its initial shrinking, the tumor may remain stationary in size for a number of years, the child becoming mummified or converted into a lithopedion, while in rare instances suppurative changes may lead to its gradual discharge, or to the death of the patient from peritonitis.

Combined and Multiple Pregnancies.—Parry stated in his monograph that 22 out of the 500 cases of tubal pregnancy collected by him were complicated by a coëxisting intra-uterine pregnancy. He designated the condition as *combined pregnancy*. The condition occurs quite frequently, and has been investigated by numerous writers. Strauss, in 1898, was able to collect only 32 cases from the literature, while Novak, in 1926, was able to increase the number to 276.

In rare instances twin tubal pregnancy has been observed, both embryos being sometimes found in the same tube, while in other cases there is a fœtus in each tube, both showing the same development. Hardouin, in 1919, collected 36 examples of the former type. Arey has also considered the subject in detail, and makes the surprising statement that single ovum twins occur many time more commonly in tubal than in uterine pregnancy. He explains the phenomenon by supposing that, in view of the difficulties experienced in becoming implanted, the rate of growth of the ovum is so retarded that two embryonic areas develop instead of one. Sänger, Krusen, and Diamant have reported cases of triplet tubal pregnancy.

Repeated Tubal Pregnancy.—Parry collected 8 cases in which tubal pregnancy had occurred a second time in the same patient, and stated that Primrose, in 1594, was the first to describe such a condition. With the increased employment of abdominal surgery, the abnormality has been recognized quite frequently, and Figure 562 represents a case in point. The first series of cases was reported by Abel, in 1893, while Pestalozza, in 1901, collected 111 cases. In several instances only a few months had elapsed between the two pregnancies, while in others they were separated by an interval of several years. Sampson and Smith hold that recurrence occurs so frequently that one is justified in removing the uterus and the nonpregnant tube at the time of the first operation. Smith states that patients who have once had a tubal pregnancy are less fertile than normal, but are exposed to a greatly increased probability of a second ectopic gestation. Thus, within five years after the primary operation 80 pregnancies had occurred in his 144 patients, in whom subsequent conception was theoretically possible, and of these 23 were repeated tubal pregnancies, and Hartmann and Bergeret noted an almost identical proportion. It is not uncommon for a repeated pregnancy to occur in the same tube; Hasselblatt has collected 21 cases from the literature, and states that many of them developed in the stump of the tube remaining after the original operation.

Effects of Extra-uterine Pregnancy upon Subsequent Childbearing.—The presence of the products of an old extra-uterine pregnancy occasionally gives rise to dystocia, and necessitates the performance of a major obstetrical operation. Thus, in the cases reported by Hugenberger, Schauta, and Sänger, cesarean section was performed; while Henningsen, Dibot, and Brossi induced premature labor, while Stein and Cheston resorted to craniotomy under similar circumstances.

As a rule, however, dystocia is not encountered, Funck-Brentano having collected 92 cases in which spontaneous labor occurred in patients still carrying the remains of a previous extra-uterine pregnancy.

Diagnosis.—Unfortunately, the symptoms to which uninterrupted extra-uterine pregnancy gives rise are usually so slight that the woman does not consult a physician, and as a result the diagnosis is rarely made before rupture or abortion occurs. If, however, a patient, presenting the usual subjective and some of the objective symptoms of pregnancy, be examined, for any reason, and a unilateral tubal tumor be found, the diagnosis is fairly certain, especially if she has been sterile for a number of years or a long interval has elapsed since her last pregnancy. In such cases the uterus is somewhat enlarged and softened, while the tubal tumor is soft and doughy, and corresponds roughly in size to the supposed duration of pregnancy. The first positive diagnosis of unruptured tubal pregnancy was made by Veit in 1883, and in this country by Janvrin in 1886.

As a matter of fact, however, it happens that when laparotomy is performed for a supposed unruptured early tubal pregnancy, a tumor of some other origin is found in about one-half of the cases. On the other hand, the unruptured pregnant tube may prolapse into Douglas' culdesac and be mistaken for the body of a retroflexed pregnant uterus, in which event an attempt at its reposition may lead to rupture and occasionally to death.

Likewise, when the fœtus has died before the occurrence of rupture or abortion, errors in diagnosis are common, as, on account of the irregular and sometimes continued uterine bleeding many cases are mistaken for incomplete uterine abortions or for pelvic inflammatory disease. For this reason, no attempt should ever be made to empty the uterus in a case of suspected incomplete abortion, unless the tubes and ovaries have been previously palpated. If a careful examination shows that a tumor is present on either side, the possibility of tubal pregnancy should be seriously considered.

It is generally taught that the discharge of a distinct decidual cast from the uterus, without evidence of a fœtus, is a characteristic sign of tubal pregnancy, especially if a tumor mass can be detected to one side of the organ; but that such a structure now and again may be discharged without the existence of pregnancy of any kind was demonstrated by Griffiths and Dakin. Formerly, such stress was laid upon the presence of decidual tissue that in doubtful cases curettage was recommended for diagnostic purposes. My own experience has taught me that while the presence of decidua in such circumstances usually affords strong presumptive evidence, its absence is not equally convincing, for in many instances the decidua may have been replaced by normal endometrium by the time the patient is examined.

The diagnosis of tubal abortion or rupture, on the other hand, usually offers little difficulty, and should be made without hesitation whenever a patient who is believed to be pregnant has complained of pain in the lower part of the abdomen, and suddenly becomes faint, deathly pale, and sinks into state of collapse, more particularly if an ill-defined sense of resistance can be detected on either side of the uterus. One should not be led astray by the fact that the patient complains of pain on the side opposite to the supposed mass, as the localization of pelvic pain is notoriously uncertain. If the collapse becomes more profound and the temperature is subnormal, rupture has probably occurred, whereas, if the patient promptly rallies, the probabilities are that one has to deal with an abortion, and the subsequent formation of an hematocele settles the question.

As has already been pointed out, rupture may occur at a very early period, even before the patient believes herself pregnant. In view of such a possibility, therefore, one should regard sudden collapse associated with symptoms of abdominal hemorrhage in a woman during the childbearing period as *prima facie* evidence of a ruptured tubal pregnancy. By so doing, and operating promptly in suitable cases, a number of lives will be saved which otherwise would inevitably be lost.

Very often the patient comes into the hands of the physician some time after she has recovered from the primary shock due to abortion or rupture. Under such circumstances vaginal examination will show a mass on one side of the uterus which is usually mistaken for pelvic inflammatory trouble. In such cases, Cullen has directed attention to the diagnostic value of a bluish discoloration of the skin about the umbilicus. Its presence may be regarded as positively indicating the existence of intraperitoneal hemorrhage, but its absence by no means precludes such a possibility. In a small number of cases, a fluctuant tumor can be felt posterior and lateral to the uterus, and when exploratory puncture through the vagina reveals the presence of a dark bloody fluid, the diagnosis of a pelvic hematocele or a broad-ligament hematoma is assured.

That the diagnosis is not always easy is shown by the fact that in the first 303 operations for extra-uterine pregnancy in the gynecological department of the Johns Hopkins Hospital, which were reported by Wynne, the preoperative diagnosis was verified in only 46 per cent. Brady reports that in the succeeding 50 cases the percentage had increased to 72; but when the facility of diagnosis in the cases of rupture is taken into consideration, it is evident that in the other types errors are frequently made.

If the child has survived the rupture, the diagnosis of secondary abdominal pregnancy is rarely made until false labor supervenes, unless the physician's attention is particularly directed to the previous history of the case. If, however, a careful physical examination is made, the uterus will be found smaller than it should be for the duration of the pregnancy, and displaced by the fœtal sac, which makes up the greater part of the abdominal enlargement. Moreover, the child can be palpated more readily than usual, and its movements are often very painful to the mother. In doubtful cases the introduction of a sound into the uterus is permissible.

The diagnosis of broad-ligament pregnancy can be made by finding the uterus pushed to one side by a tumor intimately connected with it, which at the same time depresses the vaginal vault, instead of being high up in the abdominal cavity.

The diagnosis of combined intra-uterine and extra-uterine pregnancy is rarely made until after rupture of the extra-uterine pregnancy, or unless the persistence of symptoms, following the expulsion of the uterine fœtus, leads to a very careful examination. The condition has never been diagnosed in the later months of pregnancy, although in several instances the presence of twins was recognized.

After extra-uterine pregnancy has passed full term, the diagnosis is usually easy, and is based upon the history of pregnancy followed by a false labor and a gradual decrease in the size of the abdomen. Examination shows the uterus to be practically normal in size, and displaced to a varying extent by a large tumor more or less intimately connected with it, in which the outlines of the child can occasionally be distinguished.

To recapitulate, a positive diagnosis is occasionally made before rupture, but in the majority of cases the condition escapes recognition until symptoms of collapse point to the probability of rupture or abortion. In advanced cases careful examination will usually disclose the real condition of affairs, and when full term has been passed the history is so characteristic that mistakes should scarcely occur.

Treatment.—As soon as an unruptured extra-uterine pregnancy is positively diagnosed, its immediate removal by laparotomy is urgently indicated, since rupture may occur at any time and the patient die from hemorrhage before operative aid can be obtained. The importance of immediate operation cannot be too strongly emphasized, and all methods of treatment which aim at destroying the fœtus and thus terminating pregnancy without operation are unjustifiable. This applies not only to the use of electricity, but also to the injection of various poisonous substances into the gestation sac.

Although Stephen Rogers, in 1867, suggested the propriety of performing laparotomy for the purpose of checking hemorrhage from a ruptured tubal pregnancy, Lawson Tait, in 1883, was the first to undertake such an operation. After he had demonstrated the ease with which it can be performed and the surprisingly good results obtained thereby, the procedure came into general use. Its beneficent results were clearly demonstrated by Schauta, who, in 1891, compared the results obtained in 123 cases which were operated upon with 121 cases treated expectantly, and found that the mortality was 5.7 and 86.9 per cent, respectively, and at present it is not unusual to operate upon a considerable series of cases without a fatality.

For these reasons, whenever we see a possibly pregnant woman in a state of profound collapse, and presenting a deathly pallor of the face, subnormal temperature, and other symptoms indicative of intra-abdominal hemorrhage, immediate operation is demanded, unless, indeed, her condition is so desperate that death is imminent.

The abdomen should be opened rapidly, under local anesthesia if necessary. In many cases blood spurts from the abdomen as soon as the peritoneum is incised, and completely obscures the field of operation. In these circumstances, the hand passed down alongside of the uterus seizes the tubal mass, which is then clamped on either side by long forceps. The hemorrhage having been controlled in this way, the blood clots are removed and the field of operation is cleaned up, after which the operator will be able to remove the mass and replace the clamps by ligatures, under the guidance of the eye, at comparative leisure. After the fœtal sac has been taken away, it is not advisable to attempt to remove all the blood from the peritoneal cavity, as experience teaches that it can be absorbed in great part, and thus be utilized by the patient.

Frequently the appendages on the opposite side may be the seat of chronic inflammatory lesions. Some discretion should be exercised as to their removal at this time, it being better to allow them to remain than to prolong the operation if the patient is in bad condition. At the same time, it should be remembered that their retention will predispose to a repetition of the accident, and on this account Sampson and others recommend removing the uterus along with the tubes. In desperate cases it is advisable to attempt to revive the patient temporarily by the transfusion of 500 cubic centimeters of blood before beginning the operation, and experience teaches that the time necessary for matching the bloods and finding a suitable donor is profitably spent. On the other hand, I have not been able to convince myself of the advisability of so-called auto-transfusion, in which the blood is baled out from the belly of the patient, filtered, and injected into her vein, although numerous writers, principally German, speak well of it. In less serious cases the subcutaneous or intravenous infusion of sterile salt solution should be begun while the necessary preparations for the operation are being made.

In certain cases of tubal abortion, Prochownick, Martin, and others advocate attempting to save the tube, if possible, by opening it and removing the product of conception, after which it is closed by sutures. Although, in view of the important etiological part played by follicular salpingitis, such a procedure must usually be regarded as ill-judged conservatism.

A freshly ruptured tubal pregnancy should not be attacked through the vagina, for the reason that the procedure is more difficult than a laparotomy, affords but a limited view of the field of operation, while there is always a possibility that it cannot be completed by the vaginal route.

If the patient is not seen until the acute symptoms have subsided and the effused blood has become encapsulated as an hematocele, she should be put to bed and carefully watched, operative procedures being instituted only when the hematocele increases in size or symptoms indicative of suppuration appear. Such indications are comparatively rare, as Thorn operated upon only 6 out of 157 hematoceles. When, however, the occasion demands it, excellent results are obtained by evacuating the hematocele through an incision in the vaginal fornix and packing the cavity with sterile gauze. Broad-ligament hematomata should be treated in a similar manner.

In the later months the treatment of extra-uterine pregnancy differs according as the fœtus is alive or dead. In very rare cases a living fœtus may be inclosed in an unruptured tubal or ovarian sac, or lie between the layers of the unfolded broad ligament. More frequently, however, one has to deal with a secondary abdominal pregnancy, with the child lying in the peritoneal cavity and inclosed in a sac composed of the fœtal membranes and newly formed adhesions, the placenta being within the tube or broadly implanted upon the floor of the pelvis. Whatever the anatomical conditions, the mother is constantly exposed to the possibility of sudden and acute hemorrhage so long as pregnancy continues, and accordingly prompt laparotomy is the only conservative method of treatment.

When the child has nearly attained the period of viability, certain authorities urge the propriety of deferring the operation for a few weeks in its interests. While such a course is inadvisable, it may be permissible in exceptional cases, provided the increased dangers of waiting are carefully explained to the patient and her family and accepted by them.

In a small number of cases the operation is comparatively easy and the fœtal sac can be removed as readily as a large ovarian cyst. More frequently, however, the sac is densely adherent to surrounding organs, or the placental attachment is spread over a broad area, thereby markedly increasing the difficulty of the operation, and the danger of uncontrollable hemorrhage.

Now and again, in broad-ligament pregnancies it will be found that the portion of the broad ligament immediately adjoining the uterus has not been spread apart by the growing ovum, and in such circumstances the entire sac may be removed without great difficulty by ligating the vessels at the pelvic brim and at the uterine cornu before attempting its enucleation.

As a rule, however, the complete removal of the gestation sac is by no means easy, and can only be effected by removing the uterus as well. When, as occasionally happens, it is apparent that the operation cannot be completed without seriously endangering the life of the patient, the sac should be incised, the placenta being avoided, if possible, and the fœtus extracted. The margins of the sac are then stitched to the abdominal incision, the umbilical cord is cut off short, and the cavity packed with sterile gauze, the placenta being left in situ and afterward allowed to come away piecemeal. This method necessarily entails a prolonged convalescence, but is safer than any attempt at removal of the placenta. Certain operators prefer to remove as much of the sac as possible, leave the placenta in situ, and close the abdominal incision. Experience teaches that the patients recover promptly, the placenta is in great part resorbed, or at least converted into an innocuous mass, which can be removed later, if indicated, with far less danger from hemorrhage. I, however, have no experience with the method.

The results following laparotomy in advanced cases of extra-uterine pregnancy with a living child have improved greatly since the introduction of aseptic methods. This was clearly shown by Harris, who collected 27 such cases in 1887, and 145 additional ones ten years later, with a mortality of 93 and 31 per cent respectively. Nevertheless, the operation is still one of the most dangerous which we are called upon to perform.

On the other hand, if the fœtus is dead the conditions are much more favorable, as the dangers incident to bleeding from the placental site are greatly diminished. For this reason, the operation should be deferred for six or eight weeks after fœtal death in order to permit the obliteration of the vessels supplying the placenta, and thus render possible its removal without hemorrhage. On the other hand, the operation should not be deferred too long, as there is always a possibility that the fœtal sac may become infected from the intestinal tract, when a fatal peritonitis may result.

In a small number of cases of advanced extra-uterine pregnancy operation through the vagina has been recommended. This method of procedure, however, has a very limited field, and laparotomy is usually the operation of choice.

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SECTION VII

PATHOLOGY OF LABOR

CHAPTER XXXI

DYSTOCIA DUE TO ANOMALIES OF THE EXPULSIVE FORCES

Dystocia or *difficult labor* may be due to various causes, and is most commonly encountered in the following groups of cases: (1) Those in which the expulsive forces are subnormal and are not sufficiently strong to overcome the natural resistance offered to the birth of the child by the bony canal and the maternal soft parts. (2) Those in which, although the expulsive forces may be of normal strength, abnormalities in the structure or character of the birth canal offer a serious mechanical obstacle to the descent of the presenting part. (3) Those in which the fœtus, on account of faulty presentation or excessive development, cannot be extruded by the *vis a tergo*. (4) Those cases in which accidental complications, such as eclampsia, hemorrhage, or rupture of the uterus, lead to various irregularities which interfere with the normal progress of labor.

The expulsion of the fœtus is brought about by the contractions of the uterus, reënforced during the second stage of labor by the action of the muscles of the abdominal wall. Either of these factors may be lacking in force or intensity, while occasionally they may be abnormally strong.

Unfortunately, there is no absolute standard by which the character of the labor pains can be gauged. Thus, in an exceptional primiparous woman a rapid and happy termination of labor may follow a few relatively slight pains, which in the majority of normal primiparæ would prove quite inadequate to bring about the desired result. Clinically the efficiency of the uterine contractions may be measured by their effect upon the course and duration of labor, provided there is no serious mechanical obstacle to be overcome, so that, other things being equal, prolonged or precipitate labor occurs as a result of abnormalities in their frequency and intensity.

Prolonged Labor.—Normally, in the early stages of labor, the uterine contractions recur at infrequent intervals, and gradually increase in frequency, intensity, and duration as its termination is approached. Moreover, a proper alternation between the contraction and relaxation of the uterus is a very important requisite for the successful accomplishment of delivery.

Anomalies are often noted in the first stage of labor. In many instances the pains recur at long intervals and are so feeble in character that dilatation of the cervix is unduly prolonged, with the result that labor, instead of being terminated within the usual period, may drag on for days. If the membranes are unruptured and the patient is in good condition, the delay may be regarded with equanimity, since in the great majority of instances the pains eventually become stronger and more frequent, when the birth of the child is effected without interference. For this reason, in the absence of symptoms indicative of danger to the mother or child, mere prolongation of labor is not necessarily serious; as it may happen that in a labor lasting forty-eight hours or longer the patient may suffer less and have actually fewer uterine contractions than another woman in whom the process is completed within the usual period. In such cases, the obstetrician should not interfere hastily, but should encourage the patient to bear her suffering patiently by a plain statement of the facts of the case, and the assurance that a favorable outcome may be expected, not only for her but also for the child.

Again, labor sometimes begins in a perfectly typical manner and gives every promise of an ordinarily speedy termination, and yet after a certain lapse of time, without any appreciable cause, the pains become less frequent and less intense, although giving rise to quite as much or even more suffering than previously. At the same time, the cervix, which was becoming obliterated and dilated in a satisfactory manner, ceases to make further progress, and labor apparently comes to a standstill. The former condition is attributed to primary, and the latter to secondary, inertia uteri.

In other instances, the contractions, although recurring at frequent intervals, are very painful and cramplike in character, but exert very little influence upon the dilatation of the cervix. As a result, obliteration of its canal is brought about very slowly, and the external os undergoes but little change. As a rule, such conditions do not give rise to serious complications, since under appropriate treatment the pains usually assume a more normal character, after which the termination of labor is speedily accomplished.

In all of these conditions the prolongation of labor is commonly attributed to the imperfect dilatation of the cervix, which is supposed to be due to an abnormal rigidity of its tissues. Ordinarily, however, the converse is true, and the tardy dilatation is the direct result of faulty uterine contractions. That this interpretation is correct is shown by the fact that the appearance of satisfactory contractions is promptly followed by rapid dilatation of the cervix and a happy termination of labor. On the other hand, however, especially in elderly primiparæ, who have passed their thirty-fifth year, excessive rigidity of the cervix and its consequent tardy and imperfect dilatation may be the essential factor in the production of the dystocia, especially when a further complication has been introduced by the premature rupture of the membranes.

This accident may occur before the onset of uterine contractions, and hours, days, and occasionally several weeks, may elapse between the escape of the amniotic fluid and the onset of uterine contractions. Consequently, it is unwise in such cases to express a definite opinion as to when labor will set in, but in nine cases out of ten one is safe in predicting that contractions will begin within twenty-four hours. In other cases the membranes may rupture early in labor, and before any great degree of cervical dilatation has occurred. In either event, we have to deal with what is designated as *"dry labor."* This, it is generally believed, tends to be unduly prolonged and more painful than usual, but Schultze contends that, in the absence of any other abnormality, the reverse is the case, as, upon analyzing the course of 600 such cases, she found that the duration of labor was shorter than usual. However this may be, experience teaches that certain dry labors are unduly prolonged, and in them the delay is attributed in great part to the absence of the hydrostatic action of the bag of waters, in consequence of which the dilatation of the cervix must be brought about almost entirely by the direct pressure of the presenting part, which acts as a dilating wedge of imperfect shape and consistency. According to Basset and Demelin this complication occurs in about every tenth labor, and is less serious in multiparæ than in primiparæ, on account of the decreased resistance of the cervix in the former.

This accident also increases the probability of intrapartum infection even though vaginal examinations have not been made, as bacteria from the vulva may multiply in the capillary layer of fluid in the vagina and gain access to the open amniotic sac. Fortunately, such infections are usually not serious, and all signs of them disappear within twenty-four hours after delivery, but occasionally they may lead to puerperal infection of the patient, and Warnekros has demonstrated that bacteria may be found in her blood before the completion of delivery. Even when the mother escapes infection, the condition is not devoid of danger, as it has long been known that in such cases the child, which is born alive, may succumb a few days later. Hellendahl and others thought that it became infected by swallowing the contaminated amniotic fluid, but Slemons showed that in a certain proportion of cases the bacteria make their way through the amnion covering the fœtal surface of the placenta, and, after invading the large vessels which lie just beneath it, gain access to the fœtal circulation and give rise to general septicemia or to peritonitis. Slemons designated the process as placental bacteremia, and the confirmatory observations of Zangemeister, myself and others, indicate that it plays a considerable part in the production of late fœtal mortality.

Not uncommonly obliteration of the cervical canal takes place without difficulty, while the external os alone appears to offer the obstacle to dilatation. In such cases its margins are often thin and sharp, and during a contraction may not exceed a sheet of paper in thickness. On the other hand, especially when labor is unduly prolonged, they may become thick and edematous.

In the absence of any mechanical obstacle, prolongation of the second stage of labor is rarely due to abnormalities in the uterine contractions, but rather to deficient action of the abdominal muscles. In primiparous women, especially, the tardy labor is often ascribed to the resistance offered by a rigid perineum and a small vaginal outlet, but ordinarily this is only apparent, the delay being really due to an insufficient *vis a tergo,* or to the head, which was descending with the occiput obliquely posterior, undergoing only partial rotation and being arrested in the deep transverse position.

Etiology.—Uterine insufficiency is usually attributed to one of three causes: faulty development or diseased conditions of the uterine musculature, anomalies in its innervation, or mechanical interference with its contraction. The first factor is the one most frequently concerned in the causation of tardy labor, and is especially likely to be associated with imperfect general development, being most frequently observed in patients possessing justominor pelves, but only very rarely in sufferers from rachitic deformities. It should, however, be remembered that faulty development of the uterine musculature is occasionally noted in apparently normal women, and is relatively common in large, thick set, and corpulent individuals. In Germany, a pronounced increase in the incidence of prolonged labor due to uterine insufficiency began to be noted a few years after the conclusion of the World War, and is attributed to the effect of the hunger blockade upon the development of the girls reaching puberty at that time.

Sometimes the faulty action of the uterine muscle is attributable to a loss of tonicity incident to excessive distention, and is therefore met with in women who have passed through a number of pregnancies in rapid succession, or in whom the uterus has been subjected to acute distention, as in multiple pregnancy or hydramnios. Much less commonly the defect is due to general weakness following exhausting diseases, but that this is rarely responsible is shown by the common observation that the pains are usually efficient even in patients suffering from advanced stages of tuberculosis.

It is also a matter of clinical experience that intrapartum infection is associated with uterine insufficiency, although we are ignorant as to how it is brought about.

Apart from the fact that we know that the nerve supply of the uterus is derived both from the sympathetic and parasympathetic systems, and that their action is generally antagonistic, we are almost entirely ignorant concerning the nervous control of the uterine contractions, and consequently direct proof of the existence of abnormalities in the innervation of the uterine musculature cannot be adduced; nevertheless, clinical observation indicates clearly that extraneous causes may interfere reflexly with the activity of the uterus. Thus, it is a matter of common experience that the entrance of the obstetrician into the lying-in chamber is frequently followed by a temporary cessation of the labor pains. Moreover, extreme nervousness, profound mental emotions, or excruciating pain may have a similar effect. In such cases, the severe pain is often due to the irregular action of the uterus, which in turn, by acting reflexly, interferes still further with its function, thus giving rise to a vicious circle. That reflex nervous influences are frequently responsible is shown by the fact that the administration of morphine and atropine may be followed by a return of satisfactory contractions.

That the action of the uterus is occasionally influenced by mechanical conditions is shown by the frequent association of unsatisfactory contractions with the presence of multiple myomata in the uterine wall. Much the same effect is exerted when the organ sags markedly forward in a pendulous abdomen. Old adhesions about the uterus and appendages and fresh inflammatory areas in the same location may act in a similar manner.

In the second stage defective abdominal contractions may be due to a number of causes. The insufficiency may result from faulty development of the muscles themselves—more frequently it is due to a loss of muscular tone following excessive distention, so that it is much more common in multiparous than in primiparous women. In many instances the insufficiency is only apparent, and is due to the fact that for fear of increased pain the patient is unwilling to bring her abdominal muscles into full play, and accordingly makes voluntary efforts to restrain them. For this reason the obstetrician is sometimes obliged to terminate labor by means of low forceps, although he feels sure that a few minutes' effective use of the abdominal muscles would lead to spontaneous delivery. In many such cases the induction of anesthesia is attended by happy results, since it dulls the sensation of pain sufficiently to enable the patient to bring her abdominal muscles into action.

Treatment of Prolonged Labor.—Active treatment is rarely demanded when the tardy labor is the result of infrequent pains of slight intensity, as they gradually become more severe and eventually bring about a spontaneous delivery. It is highly important that the physician should remember that the gravity of a case of labor is not measured by its duration alone, and that interference is not indicated unless objective signs of exhaustion or infection, or danger to the child, become manifest. Should the labor last for several days it is important that the moral courage of the patient be maintained, and that she should sleep well at night. Consequently, the administration of hypnotics, or even of morphine hypodermically, is indicated.

On the other hand, when the pains follow one another in rapid succession without exerting any appreciable effect upon the dilatation of the cervix, but are inefficient and cramplike, excellent results often follow the administration of a hypodermic injection of morphine (¼ grain), combined with the sulphate of atropine (1/150 grain); or of a rectal injection containing 30 grains of chloral hydrate in 4 ounces of warm milk, and repeated, if necessary, in one hour.

When the dystocia is due to secondary uterine inertia the problem is more difficult; though, as a rule, if the patient can obtain several hours of sound sleep, more satisfactory pains will appear when she wakens. For this reason the use of a hypnotic is often indicated. In other cases, the administration of 15 grains of quinine sulphate, in solution or in freshly prepared capsules, or the same amount of the hydrochlorate hypodermically, is promptly followed by a marked increase in the frequency and efficiency of the uterine contractions. If, however, the uterus does not respond to that amount of the drug, its further administration may be regarded as useless. As I have had no experience with the intravenous administration of a solution of glucose, which has been enthusiastically recommended by Miller, I cannot express an opinion as to its value.

Following the discovery by Oliver and Schäfer of the so-called pressor effect of the posterior lobe of the hypophysis, a number of years elapsed before it came to be employed as an obstetrical agent. As far as I can ascertain, such use was first mentioned by Blair Bell on December 4, 1909, when he reported that he had observed excellent results in the treatment of 3 cases of postpartum hemorrhage, including a case of placenta prævia, following the subcutaneous injection of pituitrin. The next year Foges and Hofstätter reported its satisfactory employment in 50 cases of postpartum bleeding, but it was not until January 28, 1911, that Hofbauer recommended its employment to stimulate uterine contractions during both the first and second stages of labor, basing his observations upon 12 cases. Since then an immense literature has accumulated upon the subject, and numerous preparations have been put upon the market—such as pituitrin, pituitary liquid, hypophysin, pituglandol, etc., which, however, vary greatly in their efficiency, and it has become established that the hypodermic injection of a fraction of a cubic centimeter of any efficient preparation promptly results in a great increase in the force of the uterine contractions. Many writers have therefore recommended its use in the class of cases under discussion, but, as will be indicated below, I consider its administration reprehensible during the first stage of labor.

Ergot was formerly used with a free hand in this condition, but at present is employed only by ignorant midwives. It is true that its administration may be followed by an increase in the intensity of the uterine contractions, but they soon lose their normal characteristics and become tetanic. As a result the uterus is liable to remain firmly contracted upon its contents, and, no longer alternating between contraction and relaxation, loses its expulsive power, so that the final action of the drug is to defeat the very purpose for which it was given. Moreover, if a mechanical obstacle exists, the use of ergot may lead to so pronounced an overstretching of the lower uterine segment that rupture occurs. Accordingly, it should never be employed for its oxytocic properties, but should be used only as a means for controlling uterine hemorrhage after the expulsion of the placenta.

As has already been pointed out, abnormalities in the contractions of the uterus are usually associated with imperfect dilatation of the cervix, and in elderly primiparæ, and occasionally in younger women who have suffered from inflammatory conditions about the cervix, rigidity of the tissues can sometimes be invoked as its underlying cause. In these circumstances, as well as in many cases of dry labor, the administration of a sedative is followed by satisfactory results. The use of an anesthetic, although it sometimes leads to satisfactory dilatation of the cervix, is generally inadvisable, inasmuch as the patient, having once experienced its soothing effect, refuses to dispense with it, so that the obstetrician will often be obliged to continue its employment, with the result that the uterine contractions become less frequent and efficient, and render operative interference necessary. Occasionally a hot full bath is attended by satisfactory results.

Operative interference, however, should be undertaken only in the presence of objective symptoms, indicative of profound exhaustion or infection on the part of the mother, or of actual danger to the child. In my experience, there are few obstetrical conditions which require greater nicety of judgment as to the necessity for interference and choice of procedure; for, should the result be unsatisfactory, one is usually inclined to regret his decision and to wish that he had delayed interference or had chosen some other procedure. Generally speaking, if there is no disproportion between the size of the child and the birth canal, and the cervical canal is obliterated, and resistance is offered only by an external os presenting thin margins and a diameter of five or more centimeters, excellent results may be obtained by completing the dilatation by Harris' manual method, or by Dührssen's deep incisions, and then effecting delivery by version or forceps according to the exigencies of the case. These procedures, however, should be resorted to only in the presence of some pressing indication, and should not be attempted merely for the sake of shortening the labor; for, even when manual dilatation is practiced under the relatively favorable conditions just mentioned, it frequently results in extensive laceration of the cervix, which requires immediate repair. That such a warning is necessary is shown by the fact that each year I see in consultation several women who die from hemorrhage or infection following deep cervical tears, which have resulted from unnecessary or too hasty interference.

Certain French writers, such as Balard and Mahon, claim that spinal anesthesia sometimes leads to prompt dilatation of the cervix. I have had no experience with the method, but, from what I have read, I gather that the desired result is not always obtained.

If the cervical canal has not become obliterated, manual dilatation should not be considered, but a moderate sized Champetier de Ribes bag should be introduced into the uterus. This usually acts as an efficient irritant, and brings about satisfactory contractions with resulting dilatation in the course of a few hours. If, however, the indication is urgent, and the patient shows no sign of infection, low cervical cesarean section may be indicated. On the other hand, classical section should not be thought of, as experience teaches that, whenever it is done after the first six hours of labor, it is followed by excessive mortality, so that while it may save the life of the child, it will expose the patient to an unjustifiable risk.

Tardy labor, due to the prolongation of the second stage, whether resulting from deficient uterine or abdominal action or from unusual resistance on the part of the perineum, is best treated by the application of forceps, except when the dystocia is attributable to disproportion between the size of the child and the pelvis.

Following the discovery of the oxytoxic properties of pituitary extract a great revolution has occurred in the treatment of this type of prolonged labor, and the judicious administration of pituitrin will do away with the necessity for the application of low forceps in from one-third to one-half of the cases in which it was formerly employed. Notwithstanding this apparently enthusiastic statement, I consider that great caution should be exercised in the use of the drug, as its injudicious employment may place the life of both mother and child in jeopardy. Furthermore, I feel that the claims made by several manufacturing chemists concerning its harmlessness are incorrect and reprehensible, and are calculated to lead inexperienced practitioners into therapeutic excesses to the great detriment of their patients.

As a result of my experience, I would state categorically that the use of pituitrin is absolutely contra-indicated in the presence of mechanical disproportion, or before the cervix has become fully dilated. Furthermore, in primiparæ its use is inadvisable until the presenting part has reached the pelvic floor. Its chief indications are twofold—first, in multiparæ suffering from uterine inertia, in whom labor has come to a standstill with the cervix fully dilated and the head lying below the ischial spines; and, secondly, in primiparæ, when the head has become arrested at the vaginal outlet, and it seems that only a few strong expulsive efforts are needed for its extrusion.

In many such cases, within three minutes after the hypodermic administration of three minims of a reliable preparation, the uterine contractions undergo a veritable revolution, and the pains, which were previously sluggish and far apart, become strong, regular and efficient with the result that labor is promptly terminated. The action of pituitrin is relatively evanescent, and usually becomes exhausted within fifteen or twenty minutes; consequently, if a result is not obtained within that period none can be expected, and delivery should be terminated by low forceps, instead of repeating the dose.

Occasionally, however, even when the above conditions are fulfilled, the results are not so happy, and the uterus, instead of being stimulated to regular activity, passes into a condition of tetanic contraction. In several instances this became so alarming that I felt compelled to place the patient under profound anesthesia. If this can occur during the latter part of the second stage in an otherwise normal labor, it is apparent what may happen when the head is arrested at the superior strait as the result of a contracted pelvis or an abnormal presentation, or when the cervix is only partially dilated. That the danger of rupture of the uterus is not hypothetical, is shown by the fact that Mendenhall was able to collect 89 cases from the literature up to 1929, and naturally many more were not reported. On two occasions, I was compelled to remove such ruptured uteri, after the accident had occurred outside of the clinic in order to prevent death from intra-abdominal hemorrhage.

In other cases, the excessive uterine activity may so interfere with the placental circulation that the child succumbs to intra-uterine asphyxia. I have not as yet observed such an accident, but several of my friends have, and I regard it as so real a danger that, whenever pituitrin is administered to a primipara, preparations are made so that forceps can be applied immediately should the fœtal heart sounds indicate danger, and in several instances I feel that the life of the child has been saved as the result of this precaution.

To summarize, I consider that we have in pituitrin a potent drug, which, while useful in properly selected cases, may lead to disaster if injudiciously used. Furthermore, I believe that in its employment the history of ergot will be repeated, and that, instead of being used indiscriminately as at present, its employment will be eventually restricted to several sharply defined indications; first, in conjunction with ergot, to stimulate prompt contraction of the freshly delivered uterus before the more slowly acting ergot can exert its effect; second, to replace low forceps in certain multiparous women, in whom merely a slight increase in the *vis a tergo* is required; and, third, to act as an adjuvant to castor oil and quinine in the induction of labor. Indeed, for my part, I would willingly dispense with it altogether, except for the first indication, where it serves a useful, and at times an indispensable, purpose.

Precipitate Labor.—In certain multiparous women, and very rarely in primiparæ, precipitate labor may result from an abnormally slight degree of resistance offered by the soft parts, or from abnormally strong uterine and abdominal contractions, or very occasionally from the absence of painful sensations during labor.

Generally speaking, precipitate labor is not attended by serious consequences, although the child is sometimes extruded so rapidly that the patient is unable to secure proper attention. In such circumstances deep tears of the perineum are common. It sometimes happens that the woman is suddenly overtaken by intense labor pains and gives birth to the child before she can reach her bed. In such cases, the child may fall to the ground and sustain severe or even fatal injuries. Occasionally the cord is torn through and it is generally believed that the child may bleed to death before aid is obtainable. This, however, is unlikely, as experience shows that the jagged and irregular tear, which must result in such circumstances, will probably lead to coagulation of the blood and cessation of hemorrhage before a fatal issue ensues.

If tempestuous pains come on while the patient is under the observation of a physician, they should be controlled by the administration of chloroform, in order that the head may be held back and prevented from being born too brusquely. The effects of precipitate labor have been studied particularly by Winckel.

Tetanic Contraction of the Uterus.—Occasionally in the first, and more frequently in the second stage of labor, the uterus may cease to relax at regular intervals, and passes into a condition of continued or tetanic contraction. This condition is usually encountered in prolonged labors, in which a mechanical obstacle is opposed to the passage of the child. In such cases the danger of rupture of the uterus becomes imminent, although now and again this accident may occur when everything seems to be going on normally.

So long as the tetanic condition persists, the extrusion of the contents of the uterus is out of the question; while at the same time the patient suffers intense pain, and the child is exposed to considerable danger, owing to interference with the placental circulation. If the condition is not due to an obstruction, it can be temporarily controlled by the administration of sedatives or an anesthetic, after which delivery should be effected as soon as practicable.

Contraction of Bandl's Ring.—Closely related to this form of dystocia is that which is attributable to a stricture resulting from tonic *contraction of Bandl's ring*. Considerable attention has been directed to this complication within the last few years, and numerous cases have been described by Budin, Dickinson, Hausch, Fink, Demelin and others. The French observers believe that, while the portions of the uterus above and below it remain flaccid, Bandl's ring can undergo isolated contraction, and thereby so strongly compress the neck or some other portion of the child as to interfere seriously with its delivery. Cheron has reported instances of transverse presentation in which this kind of stricture developed and confined the child to the upper portion of the uterus, at the same time offering an almost insuperable obstacle to the introduction of the hand for the performance of version.

Formerly I agreed with Veit who doubted the correctness of such observations, and held that in the cases described one had to deal with tetanic contraction of the entire active portion of the uterus. In this event, the lower uterine segment would be flabby, while the rest of the organ would be tightly contracted, thereby losing its ability to expel its contents, and at the same time making difficult the introduction of the hand or instruments into the uterus. Since 1919, however, I have met with several cases, which have convinced me that I was in error and that contraction of Bandl's ring may give rise to serious dystocia.

My first experience was with an elderly primipara, whose labor had proceeded normally until the head had reached the pelvic floor. As no further advance occurred, I applied forceps to the sides of the head anticipating an easy extraction, but was surprised to find that strong traction resulted in no advance. Upon removing the blades, I found that the difficulty was due to the fact that the neck was encircled by a rigid muscular ring, which held back the shoulders and opposed considerable resistance to the passage of a single finger past it. Under deep anesthesia I finally overcame the resistance manually, turned, and eventually extracted a living child. Within two weeks I encountered a similar condition, and have since met with it in several other patients. In one of them, cesarean section was done and the body of the uterus amputated, as I was unable to dilate the ring manually and the child was in good condition. Strange to say, all trace of the obstruction disappeared as soon as the organ was incised, and no further difficulty was experienced in extracting the child. Furthermore, careful examination of the extirpated organ failed to afford any explanation for the production of the clinical phenomenon.

Clifford White, in 1913, reported three personal cases in detail before the obstetrical section of the Royal Society of Medicine. From one patient he removed the unopened uterus, which on section showed the presence of a thick ring at the junction of its middle and lower third, which thus afforded indisputable evidence of the nature of the obstruction. In addition he was able to collect from the literature 13 cases in which cesarean section had been employed to cope with a similar complication; while Gammeltoft, in 1919, studied the question exhaustively upon the basis of 23 cases observed in the Copenhagen clinic.

In most cases, the condition relaxes under profound anesthesia so that delivery can be effected by the usual procedures. From what has been said, however, it appears that this is not always the case, and that radical intervention may appear necessary to save the life of the child. In such cases, 5 minims of 1-1000 adrenalin solution should be administered hypodermically before proceeding with the operation, as Rucker states that it usually brings about such relaxation that radical interference becomes unnecessary. I cannot recommend such treatment from personal experience, as I have not encountered a suitable case for its trial since the matter came to my attention, but in view of its simplicity and innocuousness it deserves a trial.

Hour-Glass Contraction.—As the result of the misuse of ergot, or of extensive adherence of the placenta, the uterus sometimes undergoes such an extreme degree of retraction during the third stage that the latter becomes imprisoned in its cavity. In such cases the greater part of the upper segment of the uterus is tightly contracted over the retained placenta, while its lower portion is felt by the examining finger as a tightly contracted ring below the placenta. The lower uterine segment and the cervix, not having recovered from the distention to which they have been subjected, are flabby in character, and widen from above downward to the vaginal insertion. From the shape thus imparted to the uterus, the condition is generally designated as an *"hour-glass contraction."* Its occurrence usually necessitates the manual removal of the placenta, which can sometimes be accomplished only under anesthesia.

Missed Labor.—In very exceptional instances uterine contractions come on at or near term, and, after continuing for a variable time, disappear without leading to the birth of the child. The latter then dies, and may be retained *in utero* for months, undergoing mummification or putrefaction, according as the membranes have ruptured or not. This is known as missed labor. The term should not be applied to those cases in which a living child is born, as they are probably only examples of prolonged gestation.

In the cases described by Menzies and Hennig the child had been retained for two hundred and eighty and two hundred and ten days, respectively, after full term. In the former instance it was removed at autopsy, and in the latter after incision through the cervix. Flatau has recorded an extraordinary case in which the condition persisted for fifteen years, when the fœtal bones were removed from the uterus at autopsy.

Nothing is known as to the etiology of the condition, though in the cases reported by Labhardt it was associated with carcinoma of the cervix and myoma of the uterus respectively. Cuilla is inclined to associate the phenomena with excessive fatty degeneration of the uterine musculature. It may readily be confounded with the retention of the child after the false labor following full-term tubal gestation, or with pregnancy in a rudimentary horn of the uterus, though a careful examination should preclude the possibility of such a mistake.

Labor should be induced as soon as the diagnosis is made, and in one of my patients was readily accomplished by the introduction of a bougie two months after the death of the fœtus.

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CHAPTER XXXII

DYSTOCIA DUE TO ABNORMALITIES OF THE GENERATIVE TRACT

Vulva.—Complete atresia of the vulva or the lower portion of the vagina is usually congenital, and unless corrected by operative measures would oppose an insuperable obstacle to conception. Von Meer has reported an exceptional case in which the lower two-thirds of the vagina was lacking, while the upper third communicated with the bladder. Coitus was accomplished *per urethram,* through which a three-month fœtus was subsequently expelled.

More frequently vulval atresia is incomplete, and is due to adhesions and cicatricial changes resulting from injury or inflammatory processes. The defect may offer a considerable obstacle to labor, but the resistance is usually overcome by the continued pressure exerted by the head, though frequently only at the expense of deep perineal tears.

I have seen cases in which an almost imperforate hymen had remained intact until the time of labor, and only ruptured when distended by the child's head. In rare instances, as was pointed out by Coester, a thick septate hymen may form a bridge of tissue opposing the advance of the presenting part, and may require incision before delivery can be completed.

Especially in elderly primiparæ, the vulval outlet may be very small, rigid, and altogether lacking in elasticity. This may cause dystocia and predispose to extensive laceration, unless it be avoided by deep episiotomy. Again, as the result of pressure or renal lesions, the vulva may become so edematous that its orifice is almost occluded. In these circumstances the soft parts may be so brittle that they are peculiarly liable to laceration. Moreover, when excessive edema has persisted for some time, the tone of the tissues may be so lowered that they even become gangrenous as a result of the traumatism incident to labor.

The formation of thrombi or hematomata about the vulva, although more common during the puerperium, occasionally occurs during the latter part of pregnancy or at the time of labor, and may give rise to slight dystocia. Inflammatory lesions about the vulva, as well as malignant new growths, may have a similar effect.

Vagina.—Complete vaginal *atresia* is nearly always congenital in origin, and is an effectual bar to pregnancy. Incomplete forms, on the other hand, are sometimes manifestations of faulty development, but more frequently result from accidental complications.

Very occasionally the vagina is divided into two halves by a longitudinal septum extending from the vulva to the cervix; more often the structure is incomplete, being limited to either the upper or lower portion of the canal. Such conditions are frequently associated with other abnormalities in the development of the generative tract, and their presence should always lead to careful examination, with a view to determining whether partial or complete duplicity of the uterus exists.

A complete longitudinal septum rarely gives rise to dystocia, as the half of the vagina through which the child descends gradually undergoes satisfactory dilatation. On the other hand, an incomplete septum occasionally interferes with the descent of the head, becoming stretched over it as a fleshy band of varying thickness. Such structures are usually torn through spontaneously, but occasionally are so resistant that they must be ligated and severed by the obstetrician.

Occasionally the vagina may be obstructed by ringlike strictures or bands of congenital origin. These, however, rarely offer a serious obstacle to labor, as they usually yield before the oncoming head, though in extreme cases incision may be necessary.

Sometimes the upper portion of the vagina is separated from the remainder of the canal by a diaphragmlike structure with a small central opening. Such a condition is occasionally mistaken by inexperienced observers for the vaginal fornix, and at the time of labor for the undilated external os. On careful examination, however, one should be able to pass a finger through the opening and to distinguish the cervix. After the external os has become completely dilated, the head impinges upon the abnormal structure and causes it to bulge downward. If it does not yield, slight pressure upon its opening will usually lead to further dilatation; but if this is not effectual, crucial incisions may be necessary in order to allow of delivery.

Accidental atresia is always secondary in origin, and results from the formation of cicatrices following injuries or inflammatory processes. It sometimes follows severe puerperal infections, during the course of which a great part of the lining of the vagina may have sloughed off, so that as healing occurs its lumen becomes almost entirely obliterated. A similar result is sometimes noted after diphtheria, smallpox, cholera, and syphilis; while in rare instances, as in a case reported by Schenk, it may be due to the action of corrosive fluids injected into the vagina in the hope of inducing abortion. That the most frequent cause of atresia is injury or inflammatory conditions following labor is shown by the fact that 209 of the 1000 cases collected by Neugebauer presented such a history.

The effects of such atresia vary greatly. In the majority of cases, owing to the softening of the tissues incident to pregnancy, the obstruction is gradually overcome by the pressure exerted by the presenting part; less often, manual or hydrostatic dilatation or incisions may become necessary. If, however, the structure is so resistant that spontaneous dilatation appears improbable, cesarean section should be performed at the onset of labor. Full literature concerning this complication is to be found in the articles of Ward and Brindeau.

Among the rare causes of serious dystocia, *vaginal neoplasms* are worthy of mention, Güder, in 1893, having collected 60 cases from the literature. The obstruction was due to the presence of cystic structures, fibromata, carcinomata, sarcomata, or hematomata, arising from the vaginal walls or the surrounding tissues. When the tumor is accessible it is best treated by excision, no matter what its origin. If this is not practicable, and the growth is cystic, tapping becomes the operation of choice. The presence of a solid tumor may occasionally afford an indication for cesarean section. Sasonoff observed a case in which a vaginal hematoma developed so rapidly after the birth of one twin as to interfere seriously with the delivery of the second child.

Exceptionally, *tetanic contraction of the levator ani muscle* may seriously interfere with the descent of the head. In this condition, which is analogous to the vaginismus of nonpregnant women, a thick, ringlike structure completely encircles and markedly constricts the vagina several centimeters above the vulva. Hué, in 1906, collected a number of such cases.

Ordinarily the condition yields under the influence of anesthesia, though in one of my patients the obstruction persisted in spite of profound anesthesia, and it was only after steady pressure had been exerted upon it for some minutes that it relaxed sufficiently to permit the passage of the hand folded in the shape of a cone.

Cervix.—Inasmuch as complete atresia of the cervix is incompatible with conception, it must be assumed, whenever such a condition is met with in a pregnant woman, that conception had occurred before its formation, or that the atresia is only relative.

A good illustration is afforded by the so-called *conglutinatio orificii externi.* In this condition the cervical canal undergoes complete obliteration at the time of labor, while the os remains extremely small with very thin margins, the presenting part being separated from the vagina only by a thin layer of cervical tissue. Formerly, this appearance was attributed to the existence of adhesions between the lips of the external os, but Schroeder was probably right in stating that it is simply due to a very small and resistant opening. Ordinarily, complete dilatation promptly follows from pressure with a finger tip, although in rare instances manual dilatation or crucial incisions may become necessary.

Cicatricial stenosis of the cervix frequently follows difficult labor associated with infection and considerable destruction of tissue. Less frequently it is due to syphilitic ulceration and induration, several instances of which have been reported by Le Bigot. Now and again it results from the employment of corrosive substances for the purpose of producing abortion, while occasionally it is a sequel to gynecological operations.

Ordinarily, owing to the softening and succulence of the tissues incident to pregnancy, the stenosis, whatever its cause, gradually yields to the natural forces; but in other cases dilatation has to be accomplished by manual methods or by the employment of rubber bags. In rare instances however, the stenosis may be so pronounced that it appears improbable that it can be overcome, and in such cases elective cesarean section is the procedure of choice.

In a number of my patients cesarean section was necessary on account of apparently complete atresia of the external os. As several of them had previous spontaneous labors, and as no history of inflammatory trouble or of attempts at abortion could be elicited, the cause of the condition remained doubtful. In other cases, the atresia had followed high amputation of the cervix, and in several instances no trace of an opening could be found even when the extirpated uterus was examined in the laboratory, although it must have existed at the time conception occurred. Ahlström, in 1904, thoroughly reviewed the literature.

Rigidity of Cervix.—Reference has already been made to the unyielding cervix of elderly primiparæ. Occasionally still greater rigidity is encountered in patients who have suffered from inflammatory lesions, though such conditions rarely give rise to serious dystocia. On the other hand, in certain cases of hypertrophic elongation of the cervix, spontaneous dilatation does not occur, although as a rule, one is surprised to see how completely the abnormality may be effaced during the course of pregnancy.

Uterine Displacements.—*Anteflexion.*—Marked anteflexion of the uterus is usually associated with a pendulous abdomen. In primiparæ the condition is usually indicative of disproportion between the size of the head and the pelvis; whereas in multiparæ it is more often an accompaniment of the flaccidity of the abdominal walls incident to repeated childbearing. In the latter class of cases, the abnormal position of the uterus prevents the force of its contractions from being properly transmitted to the cervix, hence the dilatation of the latter is interfered with. Marked improvement in this respect usually follows the maintenance of the uterus in an approximately normal position by means of a properly fitting abdominal bandage.

Retroflexion.—As was said in Chapter XXVII, persistent retroflexion of the pregnant uterus is usually incompatible with advanced pregnancy, since, if spontaneous or artificial reposition does not occur, the patient either aborts or presents symptoms of incarceration before the end of the fourth month. In very exceptional instances, however, pregnancy may go on to term, in which event the adherent fundus remains attached to the floor of the pelvis, while the anterior wall hypertrophies to such an extent as to afford room for the product of conception. In this condition, which is known as *sacculation,* the head of the child may occupy the displaced fundus, while the cervix is so drawn up that the external os lies above the upper margin of the symphysis pubis. Consequently, at the time of labor the contractions tend to force the child through the most dependent portion of the uterus, while the cervix dilates only partially, so that spontaneous birth is out of the question, and rupture of the uterus may occur, as in a case reported by Campbell. For these reasons cesarean section will afford the most conservative method of delivery, and at the same time make possible the reposition of the organ.

Dystocia Due to Operations for the Relief of Retroflexion of the Uterus.—Unfortunately, several of the operations which have been suggested for the relief of retroflexion of the nonpregnant uterus, while rectifying the condition, occasionally give rise to serious dystocia. At first it was generally believed that this could only follow *ventral* or *vaginal fixation* of the uterus, but as the result of my own experience I have been reluctantly forced to admit that it may also exceptionally occur after *suspension,* even when performed by competent operators with the most approved technic. Thus, it may occasionally happen, as the result of infection or some other unknown factor, that the proposed suspension becomes converted into a fixation, and as a consequence the uterus becomes firmly attached to the anterior abdominal wall by a thick adhesion, which will neither break nor stretch during pregnancy.

In this event, serious difficulty may arise at the time of labor in one of three ways: Most frequently, the anterior wall of the uterus below the area of fixation is unable to expand, so that the enlargement of the organ is effected solely at the expense of its posterior wall. At the same time the anterior wall undergoes hypertrophy, and eventually forms a thick pad of muscle extending from the point of fixation to the cervix, and which obstructs the superior strait. Furthermore, as the uterus expands, traction is made upon the cervix, which is gradually drawn upward from its normal position, until the external os is on a level with, or even above, the promontory of the sacrum, so that in extreme cases its posterior lip may be opposite the second or third lumbar vertebra. When labor sets in, dilatation of the cervix is effected very imperfectly, since the bag of waters and the presenting part, instead of impinging upon it, are forced down upon the thickened anterior uterine wall. Accordingly, the uterine contractions, no matter how strong they may be, are unable to effect the completion of labor, and, unless suitable operative aid is forthcoming, rupture of the uterus will occur, as in the cases reported by Dickinson and others.

Less frequently, as in the case reported by Lynch, the anterior wall of the uterus does not hypertrophy, and in such cases the dystocia will be due entirely to the upward dislocation of the cervix.

In other instances, as in the case which I reported in 1906, both walls hypertrophy, and because of the limited space available between the area of fixation and the cervix, the anterior wall buckles and becomes folded upon itself, instead of forming a thick muscular pad in front of the cervix. In such circumstances, the lower part of the uterine cavity is divided by a crescentic fold, with a sacculation in front of it, in which portions of the fœtus may lie, and thus be inaccessible to the operating hand. Moreover, the dystocia is exaggerated by the upward displacement of the cervix, as well as by the fold itself interfering with the engagement of the presenting part, as is indicated in Figure 559.

Andrews, in 1905, collected the histories of 395 cases of pregnancy following ventral fixation or suspension. In the 359 patients who went to full term, delivery was effected by cesarean section in 20, by forceps in 21 instances, and once by craniotomy. This, however, does not exhaust the untoward effects of the operation, as the uterus ruptured in 3 other cases, and transverse presentations were noted in 10 instances. In 1906, I was able to increase still further the list of complications, and collected from the literature 36 cases of cesarean section, as well as 2 additional cases of craniotomy. Since that time, many more cases have been reported, and the condition is now recognized as a definite factor in the production of dystocia.

In view of such experiences, the question arises whether the performance of suspensory operations of any kind is justifiable in women during the childbearing period. Formerly I held that, while ventrifixation was contra-indicated, suspension was practically devoid of danger; but, in view of what we now know, it must be admitted that the latter operation may occasionally give rise to serious dystocia. Accordingly, I feel that during the childbearing period fixation should never be done, unless it is preceded by some procedure which will effect permanent sterilization, while suspension should be practiced only when urgently indicated. For a time it was felt that Gilliam's operation would not be followed

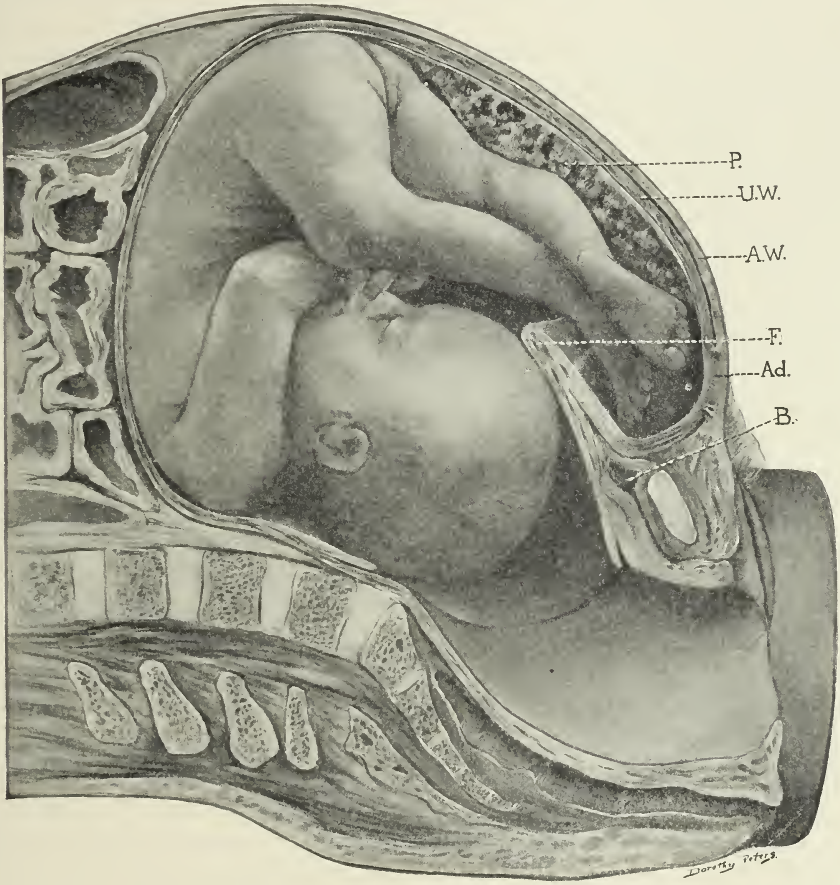

FIG. 566.—DYSTOCIA FOLLOWING VENTROSUSPENSION. SACCULATION OF ANTERIOR UTERINE WALL. × ⅓.

Ad., adhesion between uterus and anterior abdominal wall; *A.W.*, abdominal wall; *U.W.*, uterine wall; *B.*, bladder; *F.*, folded anterior uterine wall; *P.*, placenta.

by dystocia, but after my friend F. S. Newell, of Boston, had been obliged to resort to cesarean section after that operation, it is apparent that even it is not innocuous from an obstetrical point of view.

The *vaginofixation,* suggested by Dührssen and Mackenrodt, in which the fundus is firmly stitched to the anterior vaginal wall, has been followed by such serious dystocia that it has been practically abandoned during the childbearing period. Kühl has collected 9 cases of cesarean section following this operation. After Esch had reported that similar complications might follow the Schauta-Wertheim interposition operation for the cure of prolapse of the uterus, that operation became restricted to patients who had passed the menopause, or who had been sterilized by removal of the ovaries or excision of the tubes. Notwithstanding such warnings, Weibel, in 1916, reported that he had been obliged to perform cesarean section upon two patients in whom the latter precaution had been omitted.

Prolapse.—Pregnancy cannot go on to full term when the uterus is completely prolapsed, but it may do so in the incomplete variety. In the latter event the fundus occupies its usual level, while the protrusion from the vulva is made possible by elongation of the hypertrophied cervix. As a rule, the latter becomes retracted as pregnancy advances, though in rare cases it may continue to protrude from the vulva and become so edematous and swollen as to give rise to serious dystocia. Under such circumstances multiple incisions may be necessary in order to effect delivery. Even though dystocia may not result, the condition greatly increases the danger of labor. One of my patients, who was delivered spontaneously at term, was suffering from intrapartum infection when admitted to the service and died a few days later from streptococcus infection. Although she had not been examined vaginally, the fact that the external os protruded from the vulva afforded a rational explanation for the occurrence of infection.

Dystocia Due to Tumors of the Generative Tract and Pelvis.—*Carcinoma of the Cervix.*—The effect of this condition upon pregnancy and labor and its appropriate treatment has been considered in Chapter XXVII.

Fibromyomata of the Uterus.—Myomata were observed by Schauta and Pinard in 0.1 and 0.6 per cent of 55,311 and 13,915 consecutive labors, respectively. Pierson, in 1927, reported an incidence of 0.68 per cent in 50,000 labors occurring at the Sloane Hospital for Women; while Campbell noted an incidence of 0.46 per cent in our service up to 1927, but found that only slightly over one-half of the tumors gave rise to dystocia. It is a matter of general observation that women suffering from this disease are relatively sterile. Thus, 75 per cent of Schauta's patients were over thirty years of age when the first pregnancy occurred.

In many instances the association of myomata and pregnancy is without significance, while in others they are of considerable obstetrical importance for the following reasons: (1) They diminish the chances of conception; (2) they increase the probability of abortion; (3) under the influence of pregnancy, they may increase so rapidly in size as to produce serious pressure symptoms; (4) if situated in the lower segment or cervix, they may give rise to serious dystocia; (5) they favor the occurrence of abnormal presentations; (6) no matter where situated, they may so interfere with the efficiency of the uterine contractions as to give rise to inertia; (7) if submucous or interstitial in location, they may so interfere with the separation of the placenta as to render radical operative interference necessary; and finally, (8) they may undergo degenerative changes during the puerperium.

The obstacle to conception is most marked when the tumor is of the submucous or interstitial variety, and is in part due to hyperplastic changes in the endometrium which interfere with the implantation of the ovum. The correctness of such a view is demonstrated by the fact that the removal of such tumors is frequently followed by conception. Moreover, when pregnancy occurs the incidence of abortion is considerably increased, which is attributable to hemorrhagic and hyperplastic changes in the decidua, which may be associated with imperfect nidation. Furthermore, when the tumor projects markedly into the uterine cavity, and the placenta is implanted above it, spontaneous separation may become impossible, and manual removal may be so difficult that the exigencies of the condition are best met by supravaginal amputation of the uterus.

On the other hand, pregnancy is not without influence upon the tumors themselves, which frequently increase rapidly in size and give rise to serious pressure symptoms. This is in part due to actual hypertrophy, which is sometimes accentuated by the occurrence of edema. Furthermore, owing to the pressure to which they are subjected by the growing ovum, the softened tumors may undergo considerable changes in shape. Occasionally the pedicle of a subserous myoma may become twisted, and gangrene and peritonitis may ensue.

At the time of labor the effect exerted by myomata depends entirely upon their size and situation. Generally speaking, subserous tumors are without great significance, except when their large size leads to pressure symptoms, or when a pedunculated tumor prolapses into the pelvic cavity. On the other hand, interstitial myomata situated in the cervix or lower uterine segment, may so obstruct the pelvic cavity that normal delivery will be impossible. As a result of the uterine contractions, a submucous myoma may become partially separated from its bed and protrude from the cervix as a polypoid mass. In such circumstances, since it effectively prevents the descent of the head, it must be removed by cutting through the pedicle.

Even when the tumor does not interfere with the course of labor by its size and situation, it predisposes to the occurrence of abnormal presentations. Thus, Olshausen, in tabulating the cases reported in the literature, found only 53 per cent of vertex presentations, as compared with 24 and 19 per cent of breech and transverse presentations, respectively. Schauta, however, noted abnormal presentations in only 8 per cent of his personal cases. In our 82 cases, which were of clinical importance, 16 abnormal presentations occurred, namely, 2 face, 4 transverse, and 10 breech presentations. Moreover, the mere presence of the tumor may so interfere with the character of the uterine contractions as to cause inertia, as well as to favor the occurrence of postpartum hemorrhage. The latter is due partly to the fact that the myomatous nodules interfere with the normal contraction and retraction of the uterus, and partly because they may offer a mechanical obstacle to the separation and expulsion of the placenta.

In the puerperium, myomata frequently undergo degenerative changes, and if they have been subjected to prolonged pressure, may become gangrenous. On the other hand, in certain exceptional cases the effect of pregnancy is beneficent, as the tumors may undergo puerperal involution, and thus become smaller or occasionally disappear.

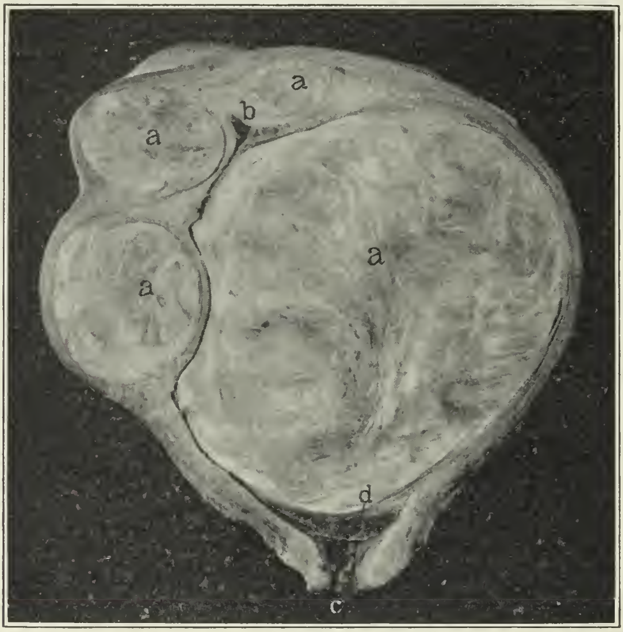

Fig. 567.—Intramural Myomata.
Retention of placenta caused by myoma. Severe infection necessitating supravaginal amputation of uterus. × ½.
a, myomatous nodules; *b,* placental site; *c,* cervical canal; *d,* decidua covering lower pole of tumor.

The diagnosis of the association of pregnancy and myomata is not always easy. Hemorrhage may occur at intervals as the result of changes in the endometrium, and be mistaken by the patient for the menstrual flow, so that the idea of pregnancy may not suggest itself for months or until an abortion occurs. On the other hand, a sudden increase in the rapidity of the growth of the uterine tumor should direct attention to the possibility of pregnancy, and the diagnosis becomes assured when careful palpation shows the presence of soft areas interspersed between the firmer myomatous nodules. Subperitoneal myomata occasionally escape observation, being mistaken for the small parts, or sometimes for the head of the fœtus, so that a diagnosis of multiple pregnancy may be made.

In preantiseptic times the outlook in the case of labors complicated by obstruction due to the presence of myomatous tumors was most serious. Thus, the maternal and fœtal mortality were respectively 25 and 79 per cent in 307 cases collected from the literature by Lefour, in 1880. At present, thanks to early diagnosis and prompt recourse to operative procedures in suitable cases, the prognosis is much more favorable. Pinard reported that labor was spontaneous in 54, and required operative aid in 30 of his cases, with a maternal mortality of only 3.6 per cent; while Schauta stated that in only 4 per cent of his cases was radical operative interference necessary.

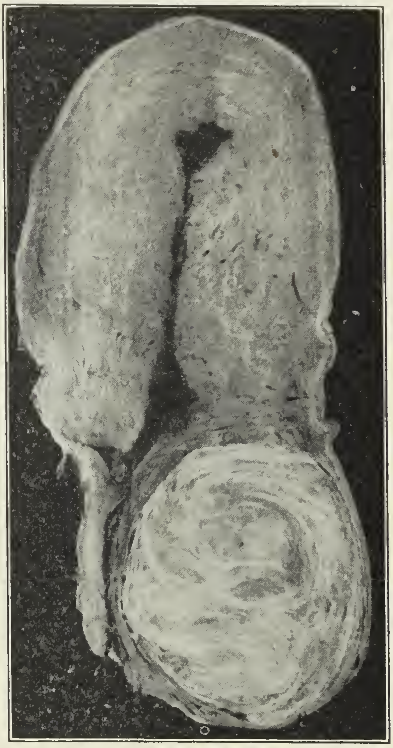

Fig. 568.—Uterus Removed by Supravaginal Amputation Following Cesarean Section Necessitated by Myoma in Posterior Wall of Cervix. × ½.

In case of extreme abdominal distention, serious hemorrhage, or symptoms of impaction occurring before the child has attained the period of viability, laparotomy is indicated; but whether removal of the tumor can be best effected by excision, enucleation, supravaginal or total hysterectomy will vary according to circumstances and the predilections of the individual operator. Generally speaking, isolated subserous myomata are best treated by excision, and those of the interstitial variety by enucleation; whereas, if numerous tumors are present, supravaginal hysterectomy is indicated without reference to the existence of pregnancy.

Myomectomy and enucleation are frequently followed by abortion or miscarriage, but do not necessarily destroy all chance of saving the life of the child. Notwithstanding this, however, my own inclination is toward supravaginal amputation, whenever operation is imperatively demanded, as being a less dangerous procedure as far as the mother is concerned. Landau, in 21 personal operations, reported a mortality of 4.8 per cent, as compared with 10.6 per cent in 471 operations collected from the literature by Carstens.

If serious symptoms do not supervene during pregnancy, operative interference should be deferred until shortly before the expected onset of labor, since the tumor may so change its shape or position as to render an operation unnecessary from an obstetrical point of view. Thus, in one of my patients, a tumor the size of a fist was found in the upper part of the cervix at the fifth month, and gave every promise of offering a serious obstacle to delivery. To my surprise, however, when she returned at the end of pregnancy for a cesarean section, the tumor had risen out of the pelvis, so that operation was not thought necessary, and a few days later an easy spontaneous delivery occurred.

So fortunate an outcome, however, cannot always be expected, and in any event the patient should be examined thoroughly, and under anesthesia if necessary, shortly before the expected date of confinement. If the tumor is found to be firmly impacted in the pelvis, cesarean section should be performed before labor sets in, followed by supravaginal amputation or enucleation, according to the judgment of the operator. On the other hand, if there is apparently no danger of impaction, and spontaneous delivery seems probable, the patient should be allowed to go into labor spontaneously. If, however, a mistake in prognosis has been made, and symptoms of obstruction occur, cesarean section should be promptly performed in preference to attempts at delivery by the more usual obstetrical procedures.

It should be remembered that the completion of labor does not necessarily indicate that all danger is passed, since, as has previously been indicated, the tumor may undergo gangrenous changes during the puerperium. Consequently, the occurrence of fever and abdominal pain should direct one's attention to such a possibility and make one consider the advisability of laparotomy, although such an indication has not as yet occurred in my practice.

Ovarian Tumors.—The presence of an ovarian tumor is one of the most serious complications of pregnancy, as it increases the probability of abortion and frequently offers an insuperable obstacle to delivery at the time of labor. Moreover, even after a spontaneous labor, its presence may give rise to disturbances during the puerperium.

While any variety of ovarian tumor may complicate pregnancy and labor, dermoid cysts have been described comparatively frequently in this connection. Thus, in 107 cases collected by McKerron, in which the nature of the tumor was stated, there were 47 cystomata, 46 dermoid cysts, 9 malignant tumors, 5 fibromata, and 2 colloid cysts; while Spencer observed dermoid cysts in 12 of his 41 patients. Swan, in 1898, was able to collect 14 cases of solid ovarian tumor.

Of the 321 pregnancies complicated by ovarian tumors which were collected by Remy, spontaneous abortion or premature labor occurred in 17 per cent of the cases. As has been indicated, tumors may also give rise to serious dystocia at the time of labor. Thus, McKerron, in 720 cases collected from the literature in which pregnancy had been allowed to run its course without interference, noted a maternal mortality of 21 per cent, while more than half of the children were lost. The majority of these cases, however, were reported prior to the general employment of radical surgical methods, very few laparotomies having been performed, and interference for the most part being limited to puncture or incision of cysts through the vagina. Moreover, the danger to the patient does not end with the birth of the child, as in not a few cases peritonitis follows gangrene of the tumor resulting from excessive pressure, while in others torsion of the pedicle may lead to a fatal termination.

Again, the cyst may rupture and extrude its contents into the peritoneal cavity during a spontaneous labor or as the result of operative interference. This event is a matter of indifference with the ordinary cystomata, but in the case of a dermoid it is frequently followed by fatal peritonitis. When the tumor occupies the pelvic cavity it may lead to rupture of the uterus, or, if that does not occur, the tumor may be forced into the vagina and occasionally even into the rectum. While spontaneous rupture may occur, it is sometimes surprising that it is not more frequent. Thus, in one of my patients a thin-walled unilocular cyst, which was impacted in the pelvic cavity, led to rupture of the uterus instead of its own walls, although the latter did not exceed one millimeter in thickness.

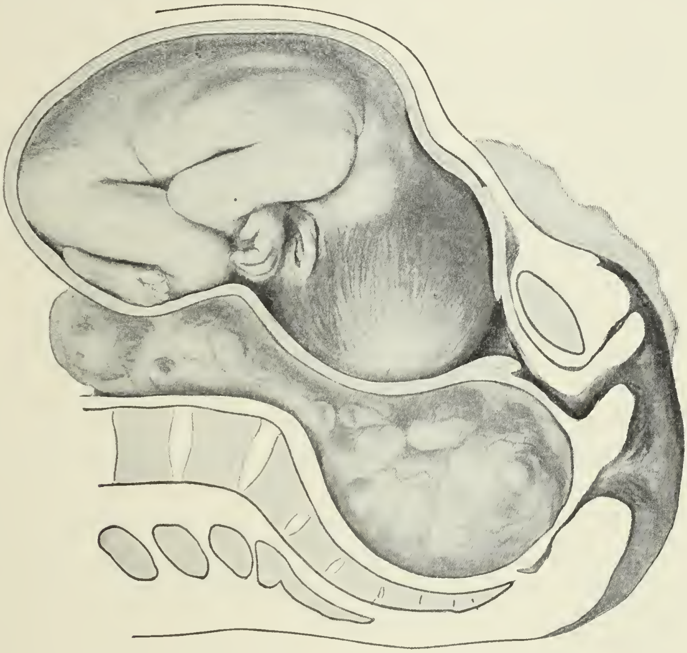

Fig. 569.—Dystocia Due to Ovarian Cyst (Bumm).

Unfortunately, the presence of an ovarian tumor complicating pregnancy often remains entirely unsuspected, the condition having been recognized in only 18 of McKerron's first series of cases. Nevertheless, careful examination of all pregnant women, particularly when they are first registered, and again four or six weeks before the calculated date of confinement, should certainly eliminate a large proportion of these errors. Moreover, failure of the presenting part to engage, when the pelvis is known to be normal, suggests an obstructing mass. On the other hand, if the tumor does not occupy the pelvic cavity, the diagnosis may be extremely difficult, as the abdominal enlargement may be attributed to the presence of twin pregnancy or hydramnios, and the true condition is not recognized until after labor.

If the ovarian tumor is detected prior to the last month of pregnancy, it should be removed immediately by laparotomy, as it is generally admitted that the operation is attended by but little danger. Thus, Heil collected from the literature 188 such operations, with a maternal mortality of 2.1 per cent.

It has been objected that such a procedure increases the chances of premature delivery, which occurred in 19.47 per cent of Heil's cases, but in only half so many of Syzmanowicz's personal cases. It should, however, be remembered that a similar accident may take place even if the patient is not interfered with, having been noted in 17 per cent of Remy's cases. This difference is so slight that the chances for the child are little, if at all, impaired by operation, while those of the mother are markedly improved.

On the other hand, when the diagnosis is not made until late in pregnancy, it is usually advisable to postpone the operation until term, for the reason that the fresh abdominal cicatrix is not well adapted to the strain of parturition. Consequently, if the tumor is impacted in the pelvis, cesarean section should be done at an appointed time, and followed by the removal of the tumor. If however, it is not impacted, I prefer to allow the patient to go into spontaneous labor and to remove the tumor later in the puerperium. Bland Sutton, Spencer and others advise that the tumor alone be removed, and that the birth of the child be left to Nature, or at most be assisted by forceps. I, however, am of the opinion that the double operation is preferable, believing that a woman should not be subjected to the strain of labor immediately following an abdominal operation.

Formerly it was advised to attempt the reposition of an impacted tumor under anesthesia. This practice, however, is not to be recommended, for the reason that the tumor may give rise to trouble during the puerperium. Moreover, since operative interference will be necessary sooner or later, it would seem far better to institute radical measures without delay. Puncture through the vagina, although strongly advocated at one time, must be considered as a dangerous and reprehensible practice, inasmuch as we possess no means of preventing the tumor contents from contaminating the peritoneal cavity, and experience teaches that the escape of the contents of a dermoid cyst is frequently followed by peritonitis. Furthermore, the statistics collected by Jones, in 1913, indicate that the procedure is attended by a greater mortality than purely expectant treatment.

After spontaneous labor has occurred, the patient should be carefully watched during the puerperium for the appearance of untoward symptoms. Should they arise, prompt operation is imperatively demanded. In any event, a woman suffering from an ovarian tumor should not be discharged from treatment until the tumor has been removed, or at least until the importance of operative procedures has been strongly urged upon her.

Tumors of Other Origin.—Labor is occasionally obstructed by tumors of various origin, which encroach upon the cavity of the pelvis to such an extent as to render delivery difficult or even impossible. In Chapter XXXVIII reference will be made to dystocia due to tumors arising from the pelvic walls.

In rare instances a normal sized or *enlarged kidney* or *spleen* may prolapse into the pelvic cavity and offer an obstacle to labor. Bland Sutton has added an additional case of displaced kidney complicating pregnancy to those collected by Cragin; and has also reported the removal of a prolapsed spleen in the second month of pregnancy, which might have given rise to serious dystocia at the time of labor had it remained in situ.

Echinococcus cysts are occasionally implanted in the pelvic cavity. Franta, in 1902, collected 22 cases noted during pregnancy and discussed their effect upon the course of labor.

In Chapter XXX reference was made to those cases in which an old extra-uterine gestation sac so obstructed the pelvic canal as to interfere with the delivery of a subsequent intra-uterine pregnancy.

Enterocele or hernia through the vaginal walls occasionally gives rise to dystocia, though in the majority of cases the prolapsed intestine can be replaced and the obstacle temporarily overcome. Where this is not possible, cesarean section is indicated as a more conservative procedure than forcibly dragging the child over a large irreducible hernia.

In occasional instances *tumors of the bladder* may likewise offer an impediment to the passage of the child, though it is rarely so serious as to demand operative interference. On the other hand, it has sometimes been necessary to remove a large calculus from the bladder before delivery could be effected. In Neer's case the stone was almost spherical in shape, and measured 2.75 inches in its greatest diameter.

A large *rectocele* or *cystocele,* though occasionally offering slight obstacle to labor, can generally be replaced while delivery is being effected.

Tumors arising from the lower part of the rectum or pelvic connective tissue may likewise give rise to serious dystocia; Pederson, in 1922, having collected a series of cases in which *carcinoma of the rectum* rendered cesarean section necessary.

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CHAPTER XXXIII

CONTRACTED PELVIS

We designate a pelvis as contracted when it is so shortened in one or more of its diameters as to effect materially the mechanism of labor, but without necessarily retarding the birth of the child. According to Litzmann, this is the case when the conjugata vera measures 9.5 centimeters or less in flat, and 10 centimeters or less in generally contracted pelves.

History.—Inasmuch as Vesalius was the first to describe the normal pelvis correctly, it is clear that the conception of abnormal forms could not have existed before his time. His pupil, J. C. Arantius (1530-1589), gave the first anatomical description of such a pelvis, but his discovery exerted no appreciable effect upon the obstetrical art of the period, for the reason that Ambroise Paré still held to the old view of the separation of the pubic bones during labor, and promulgated it in his writings.

During the next century knowledge of the subject advanced but slowly, and we find Mauriceau (1637-1709) stating that in his large experience he had observed only two instances of contracted pelvis. In one of these Chamberlen was permitted to apply the forceps invented by his uncle, but failed to effect a delivery.

We are indebted to Hendrik Deventer for our first knowledge of contracted pelves from an obstetrical standpoint. In his *New Light for Midwives,* which appeared in 1701, he described the generally contracted and the flat varieties, and discussed the influence which they exert upon labor. From that time on mention of the subject is to be found in all the textbooks, De la Motte, Puzos, and Dionis being the obstetricians of the first half of the eighteenth century who devoted most attention to it. The last-named observer was the first to point out the causal relation which rachitis bears to many cases of pelvic deformity.

Important contributions to the subject were made by Smellie. In his treatise "The Theory and Practice of Midwifery," published in 1752, is to be found an excellent description of the normal pelvis, as well as of the more usual varieties of deformity to which it is subject. He also laid down practical rules for the estimation of the degree of contraction, carefully described the mechanism of labor in such cases, and gave excellent pictures showing the influence exerted by the contracted pelvis upon the fœtal head.

Baudelocque (1746-1810) contributed largely toward the development of our knowledge of the subject, as he devoted particular attention to the recognition of the condition in the living woman, and showed that it could be effected by measuring the distances between certain external bony points of the pelvis by means of a pair of calipers. He was the first to describe the external conjugate, which is now generally known by his name, and taught that by deducting 3 inches from it the length of the conjugata vera could be readily and accurately estimated.

At the same time G. W. Stein, in Germany, did good work upon somewhat similar lines and devised a pelvimeter for the direct mensuration of the conjugata vera.

The real foundation, however, for our modern doctrine was laid by Michaelis and Litzmann. The former was Professor of Obstetrics in the University of Kiel from 1843 to 1850, and during that time carefully measured the pelvis in 1000 consecutive cases of labor. He designated as contracted all pelves in which the conjugata vera measured 8.75 centimeters or less, and found 72 such cases a percentage of 7.2. After his death he was succeeded by Litzmann, who continued his work, and soon reported accurate measurements based upon a second series of 1000 cases. He advanced the definition which is given at the beginning of the present chapter, and placed the upper limit at a conjugata vera of 10 or 9.5 centimeters, according as the pelvis is generally contracted or flat, respectively. Judged by these criteria he found 14.9 per cent of abnormal pelves, and estimated that had Michaelis employed the same standard his percentage would have been 13.1.

Litzmann's definition and criteria have been adopted throughout the world, and since the appearance of his work scientific obstetricians have devoted an increasing amount of attention to the subject. To mention all who have added materially to our knowledge would be equivalent to writing the history of obstetrics since 1839; but Naegele, Kilian, Schauta, and Breus and Kolisko may be cited as among the most important contributors.

Frequency.—In this country and in England very few statistics are available upon which to base accurate statements as to the frequency of contracted pelves, but in Germany and France many of the large lying-in hospitals supply valuable data. The incidence varies considerably in different countries, and even in various parts of the same country. Thus, as is shown by the following table, it ranges from 8 to 24 per cent in various German clinics.

Observer	Per Cent	Cases
Goenner (Basel)	7.9	2433
Pfund (Munich)	9.5	1199
Fuchs (Erlangen)	11.43	1766
Köttgen (Bonn)	13.45	2000
Litzmann (Kiel)	14.9	1000
Müller (Berne)	16	1177
Weidenmüller (Marburg)	18.7	3224
Baisch (Tübingen)	24	3375
Leopold (Dresden)	24.3	2415

Statistics based upon large series of cases are not available for France. Commandeur, however, places the incidence at 15 to 20 per cent, and states that it is

Pinard's belief that it has been greatly lowered since the last years of the nineteenth century following the introduction of more rational methods of infant feeding.

Fancourt Barnes, in 1897, reported that only 0.5 per cent of contracted pelves were observed in 38,065 cases of labor in London. In view of the fact, however, that every year many cesarean sections are performed in that city for this indication, it would appear probable that his figures in no way represent the true condition. On the other hand, the extraordinary frequence of abnormal pelves in Glasgow is proverbial.

It has been a matter of general belief that contracted pelves are very rare in America, and Dewees stated in 1824 that he had observed only three cases in his large experience. Lusk held a similar opinion, and said that rachitis is rarely, and osteomalacia never, observed among native American women. We owe to Reynolds the first statistical statement upon the subject. In 1890, he reported that he had observed 1.34 per cent of contracted pelves in the cases requiring operative interference in a series of 2227 women delivered in Boston. Had he also taken into account the cases in which labor terminated spontaneously, he would, in all probability, have reported a frequency of 6.8 per cent. Flint, in 1897, observed 8.46 per cent of contracted pelves in 10,233 consecutive patients delivered by the Society of the New York Lying-in Hospital.

Since the opening of the lying-in department of the Johns Hopkins Hospital, it has been our rule to measure both externally and internally the pelvis of every pregnant woman coming into our hands. In 1899, I reported that we had met with 131 contracted pelves in the first 1000 women delivered.

Since then I have made repeated contributions to the subject, which are summarized in a report by Sun and myself. This series includes 11,630 different women who were delivered at term in the clinic, and 3100 of them presented contracted pelves of all types. Upon analyzing them according to race, it was found that the usual types of inlet contraction occurred much more frequently in colored women—namely, 574 in 6407 white women, as contrasted with 1949 in 5223 colored women, an incidence of 8.96 and 37.31 per cent, respectively. Furthermore, after the first 2000 cases the dimensions of the inferior strait were also measured, all pelves being designated as "funnel" in which the distance between the tubera ischii measured 8 centimeters or less. Judged by this criterion 6 per cent of the patients presented outlet contractions, but in contrast to the contractions involving the superior strait, no great difference was noted between the two races—the exact incidence being 5.03 and 6.4 per cent in the white and black women, respectively.

Accordingly, in my service contraction of the pelvic inlet occurs over four times more frequently in black than in white women, while funnel pelves are equally frequent in the two races. In other words, every eleventh white and every third colored woman in Baltimore has a typical contracted pelvis; while, in addition, every sixteenth woman in either race has a funnel pelvis. Hence, it is evident that no one can practice obstetrics without frequently encountering such conditions.

As will be explained in detail later, the preponderance of the usual types of contracted pelvis in colored women is due to the prevalence of rickets, as well as to the general physical degeneration which seems to overtake members of that race who are raised in large cities. That labor is not more disastrous to them is due to the fact that their children are smaller and have softer heads than white children, as was demonstrated by my former assistant, T. F. Riggs.

That contracted pelves are not limited to civilized peoples is indicated by the observations of Emmons and Acosta-Sison. The former studied the pelves of 217 American Indian squaws and found that 29 per cent were abnormal; while the latter has stated that in Filipino women the pelvic conditions are practically identical with those observed in the American Negress.

Methods of Diagnosis.—It is essential that the obstetrician be able to determine the existence and extent of the contraction before the onset of labor, in order that he may, as far as possible, decide in advance upon the proper treatment to be instituted in each case. With this in view, accurate pelvic mensuration should constitute an integral part of the examination of the pregnant woman, and, in the present state of our knowledge, a physician who practices obstetrics without pelvimetry must be regarded as no better than one who treats diseases of the heart and lungs without the aid of auscultation and percussion.

At the first prenatal examination, which should be made as early as possible in pregnancy, the physician should utilize every means of obtaining all possible data bearing upon the case; whereas at the final examination, three or four weeks before the expected date of confinement, he should determine whether there is any disproportion between the size of the head and the pelvis, and its degree if it exists. Generally speaking, large, well-built women are likely to have normal, and undersized women contracted, pelves; but this rule by no means always holds good, and it is not unusual for examination to disclose some abnormality in the former and normal pelves in the latter.

The gait of the patient should be carefully noted, since the existence of a limp or some peculiar way in which the feet are placed upon the floor may serve to direct attention to the possibility of a pelvic deformity. Marked abnormalities of the spinal column—kyphosis or lordosis—are also suggestive, and even slight degrees of spinal curvature should not be overlooked, as they are frequently of rachitic origin. The more usual signs of rachitis—deformities of the extremities, the characteristically shaped head, and the rachitic rosary—should always be looked for. Likewise, inquiry should be made as to the age at which the patient first learned to walk, and if she is found to have been backward in this respect the possibility of a rachitic pelvis should be borne in mind, even though the usual external manifestations of the disease may be lacking.

If the patient has already borne children she should be questioned as to the course of previous labors, and the history of any serious difficulty should always suggest the possibility of an abnormal pelvis. On the other hand, a negative history is by no means so valuable, as it is a well-known fact that in moderate degrees of pelvic contraction the first labor may be relatively easy, while each successive one becomes more difficult. In primiparous women a pendulous abdomen, or the failure of engagement of the head in the last month of pregnancy, should always arouse suspicion as to the existence of disproportion between the head of the child and the pelvis, and should not be dismissed until careful examination shows that such is not the case.

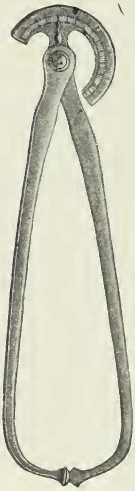

FIG. 570.—BUDIN'S PELVIMETER.

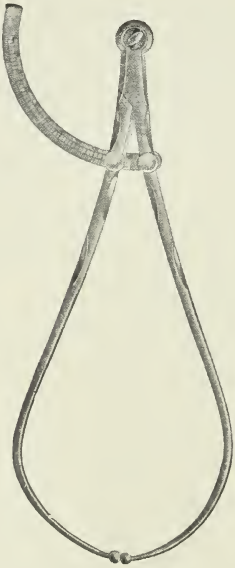

FIG. 571.—MARTIN'S PELVIMETER.

Pelvimetry.—While the abovementioned conditions are of value in suggesting the possibility of pelvic deformity, accurate information as to its existence and extent can be obtained only by measuring the pelvis.

For this purpose external and internal pelvimetry are employed, according as the measurements are taken from the surface of the body or through the vagina. As has already been said, Baudelocque was the first to insist upon the importance and value of the former, and invented the first pelvimeter, which consisted of a pair of calipers or compasses provided with a scale to indicate the extent to which they are opened. Innumerable instruments of this kind have since been devised, but, although most of them give satisfactory results, before buying one it is always well to see that the blades are sufficiently curved to allow them to span the thighs of stout patients. Thus, Budin's pelvimeter (Fig. 570), which can readily be carried in the pocket, gives satisfactory results in the majority of cases; but it cannot be used to measure the external conjugate in stout women, owing to the slight curvature of its blades. I usually employ the instrument devised by E. Martin (Fig. 571).

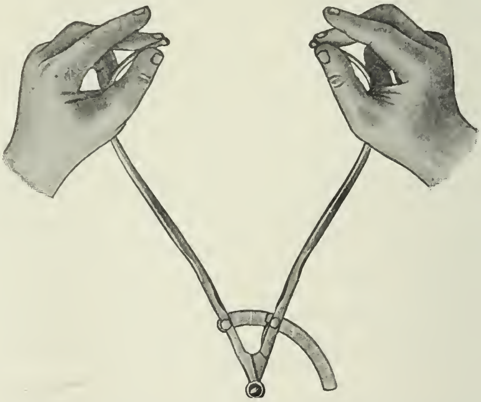

FIG. 572.—METHOD OF HOLDING PELVIMETER.

(*a*) EXTERNAL PELVIMETRY.—The ordinary measurements are four in number: the distance between the anterior superior spines of the ilium, between the crests of the ilium, between the heads of the trochanters, and between the depression beneath the spinous process of the last lumbar vertebra and the anterior surface of the symphysis pubis. Normally these measure 26, 29, 32, and 21 centimeters, respectively, in the living woman. Naegele suggested certain other measurements, which, as a rule, are not employed unless one suspects the existence of an obliquely contracted pelvis.

When the pelvis is to be measured externally, the patient should lie upon a bed or table with her abdomen and hips either bared or covered only by a thin chemise. The legs and upper portions of the body should not be exposed. In order to make the first three measurements, the physician should face the patient. He then grasps the tips of the pelvimeter between the thumb and second finger of each hand, and, having located the outer edges of the *anterior superior spines* with the index fingers, presses the tips of the pelvimeter upon them as closely as possible, the distance between them being indicated on the scale.

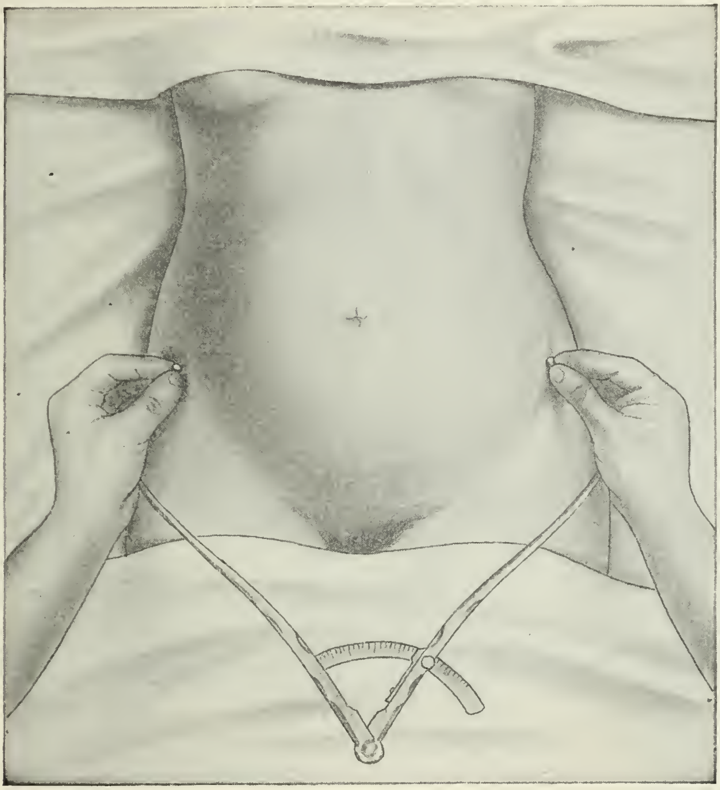

FIG. 573.—MEASURING THE DISTANCE BETWEEN THE ANTERIOR SUPERIOR SPINES.

In measuring the distance between the *iliac crests,* the most widely separated portions are located, and the tips of the pelvimeter applied to their outer edges. In taking these measurements, it should be borne in mind that the iliac spines and crests present an outer and inner lip and an intermediate ridge, and that the distance between the outer lips, which we measure, is 1.5 to 2.5 centimeters greater than that between the inner lips.

In determining the distance between the *trochanters,* the patient's legs having been brought into close apposition, the examiner carefully palpates the upper portion of the thighs until the most prominent points of the trochanters are felt on either side. The tips of the pelvimeter are then firmly pressed against them, so that they come into the closest possible contact with the bones, after which the measurement is read off on the scale.

The external conjugate, or *Baudelocque's diameter,* extends from the depression just beneath the spine of the last lumbar vertebra to the anterior and upper margin of the symphysis pubis. For this measurement, the woman should lie on her side with her back toward the physician. As a rule, the spine of the last lumbar vertebra is quite prominent, and is readily found by palpating and counting the spinous processes from above downward. Immediately beneath it is a slight depression, which forms the posterior extremity of the diameter to be measured. Into this one tip of the pelvimeter should be inserted and held firmly in place, while the other hand seeks the upper margin of the symphysis pubis, and firmly applies the other tip of the pelvimeter to it. The distance separating them is then read off on the scale.

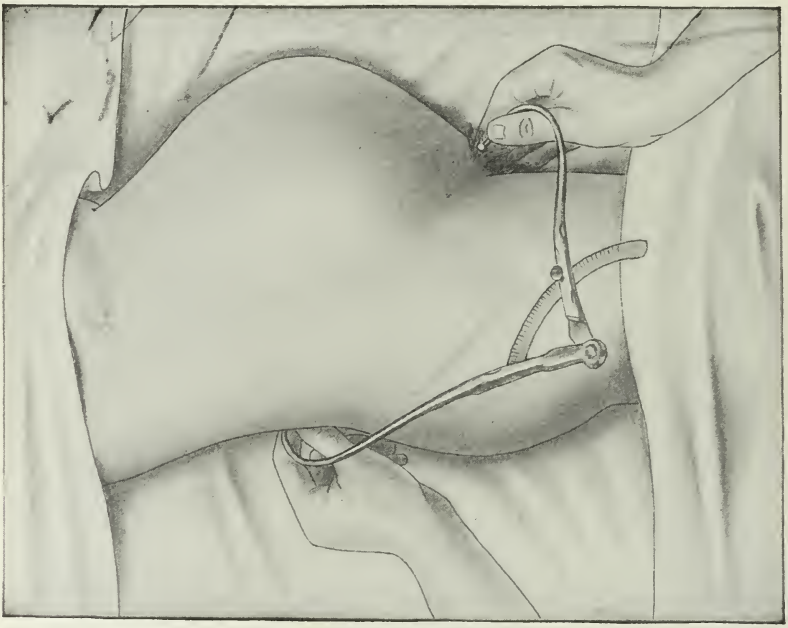

FIG. 574.—MEASURING THE EXTERNAL CONJUGATE.

In stout women some difficulty may be experienced in locating the posterior extremity of this diameter, owing to the fact that the spinous process of the last lumbar vertebra cannot be identified. This difficulty can usually be obviated in the following manner: The depressions marking the attachment of the fascia to the superior posterior spines of the ilium, which are usually clearly visible, are located, and the ball of the thumb applied over one and that of the second finger over the other. The index finger then seeks the spine of the last lumbar vertebra, which will usually lie about 2.5 centimeters above the line joining the thumb and second finger, or at the apex of a four-sided space—Michaelis's rhomboid—whose upper and lower margins are formed by the transverse and sacrospinalis and gluteus muscles, respectively.

The Value of External Pelvimetry.—Baudelocque, in describing the external conjugate, stated that by deducting 3 inches from it the length of the true conjugate could be accurately estimated. He based his opinion upon the fact that he had rarely observed a difference of more than 1 or 2 lines between the estimated and the actual conjugata vera in 30 odd cases which he had compared the measurements taken during life and at autopsy. Later experience, however, has shown that his conclusions were erroneous, and that the length of the external conjugate gives a very imperfect idea of that of the conjugata vera, since several modifying factors may exist. Thus, the amount to be deducted varies with the thickness of the sacrum and of the symphysis pubis, and also depends, to a great extent, upon the elevation of the promontory of the sacrum and the length of the spinous process of the last lumbar vertebra. Unfortunately, these factors cannot be accurately estimated in the living woman, and Skutsch has shown that in 100 pelves examined by him the difference between the length of the external and of the true conjugate varied from 5.5 to 10 centimeters. Baisset arrived at similar conclusions after studying 120 dried pelves; and I have in my possession two specimens whose true conjugates are of equal length, yet whose external conjugates show a difference of 5 centimeters.

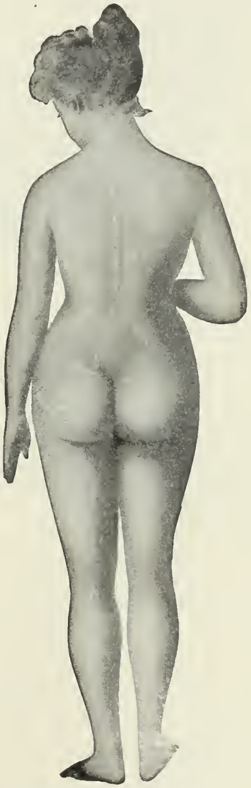

Fig. 575.—Michaelis's Rhomboid (Stratz).

Although the measurement of the external conjugate does not give accurate information concerning the length of the conjugata vera, it nevertheless enables us to draw certain important conclusions. Thus, generally speaking, when the former measures between 20 and 21 centimeters, the conjugata vera will rarely be found to be shortened; when, however, it measures between 18 and 19 centimeters it should be regarded as a danger signal, as in about one-half of such cases the length of the conjugata vera will be found to be decreased; and when it is below 17 centimeters pelvic contraction is almost uniformly present.

It was formerly believed that one could form a fairly accurate estimate of the length of the transverse diameter of the superior strait by making certain deductions from the distances between the anterior superior spines and between the crests of the ilium. The incorrectness of this conclusion, however, was first demonstrated by Scheffer, who showed that the transverse diameter of the superior strait may be of the same length in two pelves, while at the same time the distances between the iliac crests vary by as much as 3.3 centimeters. This source of error depends in great part upon the angle which the iliac fossa forms with the rest of the innominate bone, and the extent to which its anterior portion is flared out.

The distance between the trochanters is the least valuable of all the external measurements, as its length depends, to a great extent, upon the angle which the neck of the femur forms with its shaft; and as a consequence its shortening, unless very marked, does not indicate a corresponding decrease in the transverse diameters of the pelvic cavity.

Goenner, in 1901, demonstrated that external pelvimetry alone gave a very erroneous idea concerning the existence of contracted pelvis. After measuring the external diameters in 100 cadavers, he compared them with those of the pelvic cavity when measured directly, and found that, whereas the former indicated that nearly all of the pelves were contracted, the latter proved that such was the case in only 22 instances. My own observations bear out his conclusions; as the use of the external measurements alone would indicate the presence of contracted pelvis in three-quarters of all colored women, as compared with one-third shown by internal pelvimetry.

Nevertheless, despite many possible inaccuracies, the external measurements are of considerable value, in that they serve to indicate with tolerable certainty the type of pelvis with which one has to deal. Normally the distance between the spines is 2.5 to 3 centimeters less than that between the crests; but in the rachitic pelvis, owing to the flaring of the iliac spines, this proportion becomes deranged, and the two measurements approximate each other, the former frequently being equal to, and occasionally exceeding the latter. If, however, both measurements are considerably below the normal, but preserve their usual relation to each other, and at the same time the external conjugate is also proportionately shortened, it is permissible to conclude that the entire pelvis falls below normal in all its diameters, or, in other words, is generally contracted.

It is my rule to employ both external and internal pelvimetry at the first prenatal examination, and thus to gain an accurate knowledge of the pelvic dimensions at the first visit of the patient. On the other hand, if she is not seen until after the onset of labor, and the child's head is already deeply engaged in the pelvic cavity, I content myself with external pelvimetry; whereas, if the head is not engaged, internal pelvimetry becomes obligatory, as only by its means can occasional unpleasant surprises be obviated.

(*b*) INTERNAL PELVIMETRY.—In the majority of abnormal pelves the most marked deformity affects the anteroposterior diameter of the superior strait, and as a consequence we are especially anxious to ascertain the length of the conjugata vera. Unfortunately, this cannot be measured directly in the living women, except by means of especially constructed instruments, concerning whose accuracy there is no unanimity of opinion, and consequently in practice it is estimated after measuring the diagonal conjugate—the distance from the promontory of the sacrum to the lower margin of the symphysis pubis—and making a certain deduction from it. This method was introduced by Smellie, and still further elaborated by Baudelocque.

Measuring the Diagonal Conjugate.—For this purpose the patient should be placed upon an examining table with her knees drawn up, and her feet supported by suitable stirrups. If this cannot be conveniently arranged, she should be brought to the edge of the bed and a firm pillow placed beneath her buttocks. Two fingers are introduced into the vagina, and, before measuring the diagonal conjugate, the motility of the coccyx is determined and the anterior surface of the sacrum is palpated. The first is ascertained by seizing the coccyx between the fingers in the vagina and the thumb externally and attempting to move it to and fro. The anterior surface of the sacrum is then methodically palpated from below upward, and its vertical and lateral curvature noted. In normal pelves only the last three sacral vertebræ can be felt without pushing up the perineum, whereas in markedly contracted varieties the entire anterior surface of the sacrum is readily accessible.

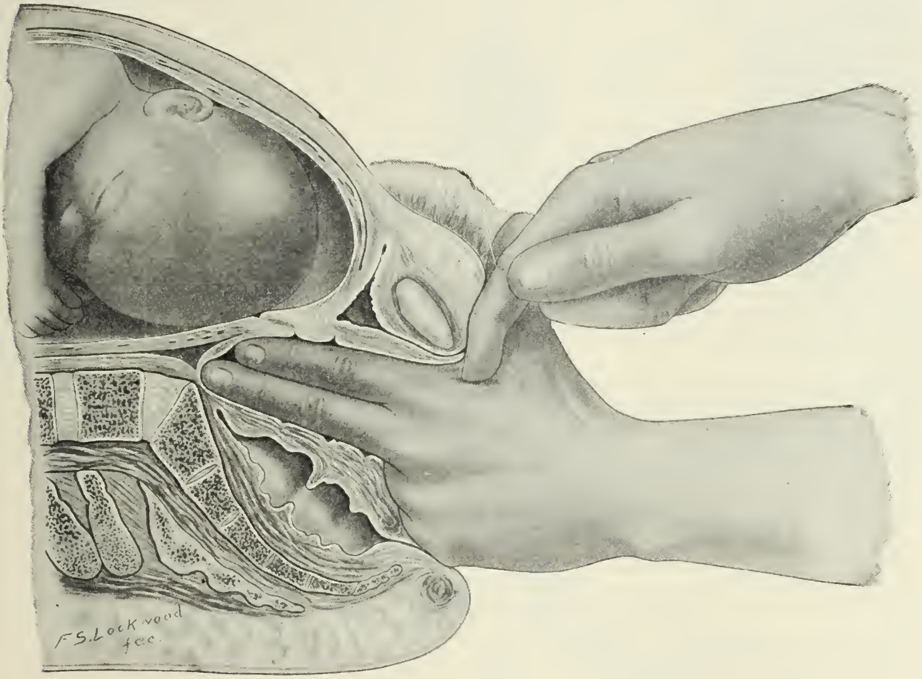

Fig. 576.—Measuring the Diagonal Conjugate.

Except in extreme degrees of contraction, in order to reach the promontory

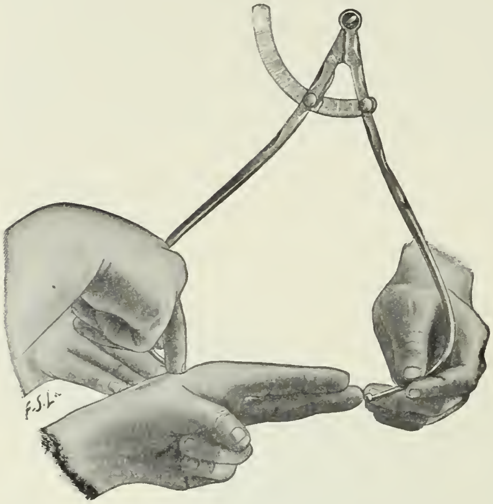

Fig. 577.—Measuring the Length of Diagonal Conjugate upon the Fingers.

of the sacrum, the elbow must be depressed and the perineum forcibly pushed upward by the knuckles of the third and fourth fingers. In order to effect this, it is customary for the examiner to place one foot upon stool and to rest against the knee the elbow corresponding to the examining hand. Then, by moving the knee, strong pressure can be exerted without interfering with the motility of the wrist or of the examining fingers. The index and second finger, firmly held together are carried up over the anterior surface of the sacrum when by sharply depressing the wrist the promontory is felt by the tip of the second finger as a projecting bony margin at the base of the sacrum. With the finger closely applied to its most prominent portion, the hand is elevated until the radial surface of the index finger is brought into close contact with the pubic arch. This point is then marked by the nail of the index finger of the other hand, after which the fingers are withdrawn from the vagina and the distance between the mark and the tip of the second finger is measured (Figs. 576 and 577). This represents the diagonal conjugate, from which the true conjugate is estimated by deducting 1.5 to 2 centimeters, according to the height and inclination of the symphysis pubis.

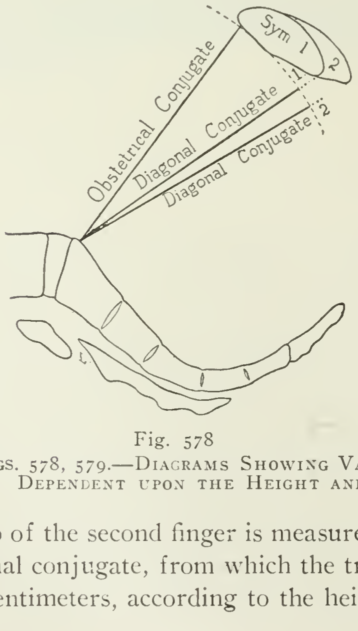

Fig. 578

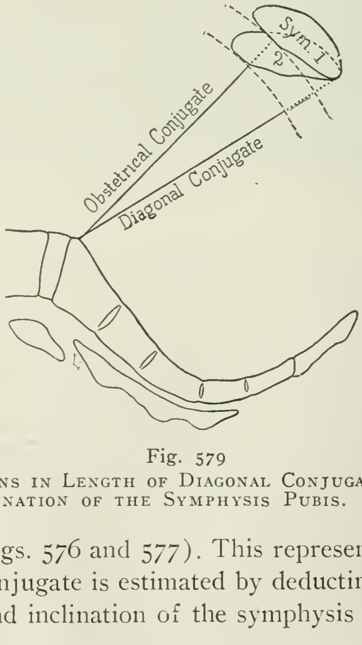

Fig. 579

Figs. 578, 579.—Diagrams Showing Variations in Length of Diagonal Conjugate Dependent upon the Height and Inclination of the Symphysis Pubis.

In this method the problem consists in estimating the length of one side of a triangle, the conjugata vera; the other two—the diagonal conjugata and the height of the symphysis pubis—being known. Were we able to measure satisfactorily the angle formed between the symphysis and conjugata diagonalis, the exact length of the true conjugate could readily be ascertained by the ordinary rules of trigonometry. Unfortunately, this cannot be done accurately in the living woman, but for practical purposes it suffices to estimate the length of the diagonal conjugate as just described, deducting 1.5 centimeters from it if the pubis is low and slightly inclined, and 2 centimeters if it is high and has a marked inclination. The rationale of this is clearly shown in Figures 578 and 579. The length of the diagonal conjugate also varies according to the position of the promontory, being longer when it is elevated, and *vice versa* (Fig. 580). Van der Hoeven (1912) has pointed out the fallacies involved in indirect mensuration, and holds that they are so great as almost to destroy its usefulness.

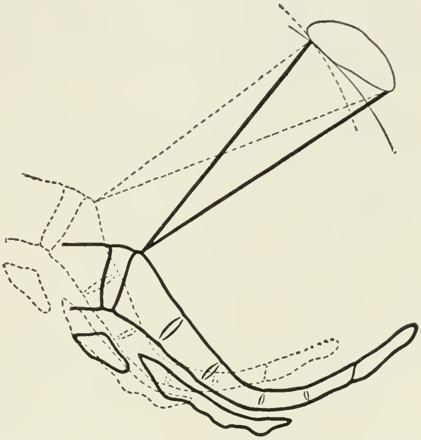

Fig. 580.—Diagram Showing Effect of Position of Promontory of Sacrum upon the Length of the Diagonal Conjugate.

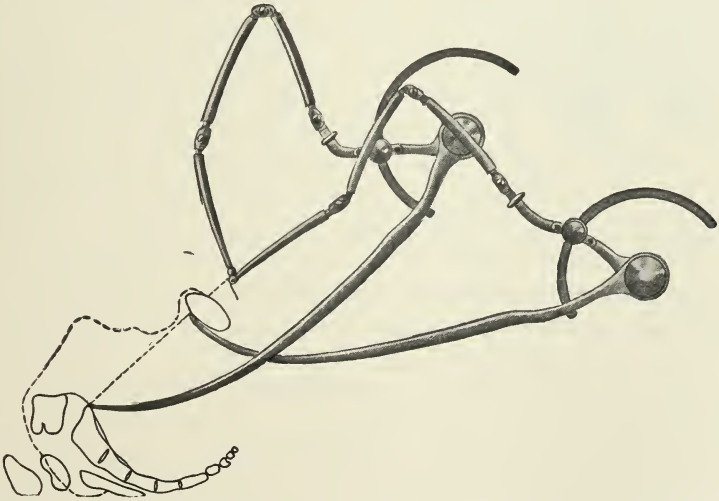

Fig. 581.—Measuring Conjugata Vera with Skutsch's Pelvimeter.

Since the time of G. W. Stein (1772), numerous instruments have been devised for the purpose of measuring the conjugata vera directly; but unfortunately the majority of them, while theoretically correct, are practically useless on account of the difficulty of their application. Descriptions and illustrations of many of them are to be found in Skutsch's excellent monograph.

Skutsch, in 1886, devised a pelvimeter by which the conjugata vera could be indirectly, though accurately, measured (Fig. 581). Hirst more recently described a simple device for the same purpose. Both of these instruments give fairly satisfactory results when properly used, but their employment is usually so painful to the patient as to require the administration of an anesthetic.

Since 1904, renewed interest has been manifested in the direct mensuration of the conjugata vera, and Bylicki, Gauss, Zangemeister, and others have devised instruments for the purpose. In the hands of their inventors such pelvimeters have proven satisfactory, but others have found that their employment gives no more accurate results than can be obtained by the indirect manual method. I have not been able to use the instruments of Gauss or Zangmeister in primiparous women, except under anesthesia; and, even when the vaginal outlet is so relaxed that they can be employed without undue pain, the results obtained have not seemed especially accurate, except when the degree of contraction was very pronounced.

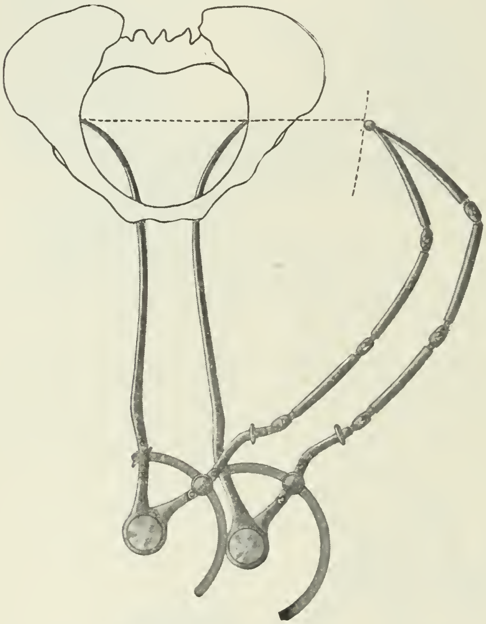

Fig. 582.—Measuring Transverse Diameter of Superior Strait with Skutsch's Pelvimeter.

Jacobs, in 1928, devised a very ingenious instrument which he has designated as the obstetric inclinometer. By its means he determines the height and inclination of the symphysis pubis, as well as the length and inclination of the diagonal conjugate. After making these determinations, he reassembles the instrument away from the patient, and reads off on a measuring rod the length of the conjugata vera. The instrument is based upon the same general idea as that of Gaszynski, but unlike it does not necessitate complicated mathematical calculations. In the hands of its inventor it gives satisfactory results; but my experience with it has been too slight to permit definite statements as to its utility.

Measuring the Transverse Diameter of the Superior Strait.—This diameter cannot be measured directly in the living woman, and, as a rule, for all practical purposes it is necessary only to palpate the linea terminalis with the examining fingers, and in that way roughly estimate the outlines of the superior strait. If, however, we wish to be more exact, its length can be ascertained approximately by the employment of Skutsch's instrument (Fig. 582).

Löhlein attempted to estimate the size of this diameter by adding a "constant" to what he designated as the ascending oblique diameter. This extends from the lower margin of the symphysis pubis to the anterior and upper margin of the sacrosciatic notch, and can be measured by the finger. As the investigations of Steinbrecher show that the size of the "constant" varies in the several varieties of deformed pelvis, it is apparent that only approximate results can be obtained by this means.

Contractions of the Pelvic Outlet.—As has already been indicated, contractions of the pelvic outlet occur in about 6 per cent of all women, and probably represent the most common type of abnormality encountered in the American white woman. As they may give rise to serious dystocia, they should receive more extended consideration than they are usually accorded. The contraction may be limited to the transverse or to the anteroposterior diameter, or may involve both, and be either symmetrical or irregular in character. Leaving out of consideration the cases associated with kyphotic, osteomalacic, obliquely contracted, and other rare varieties of abnormal pelves, it frequently happens that pronounced deformity of the outlet occurs in pelves presenting otherwise normal measurements.

Measuring the Diameters of the Pelvic Outlet.—In view of what has just been said, the determination of the space available between the tubera ischii should be made an integral part of the routine examination of the pelvis. An approximate idea may readily be obtained by Sellheim's method of palpating the pubic arch. For this purpose, the woman having been placed in the dorsal position with the hips protruding beyond the edge of the examining table and the legs drawn up, each buttock is grasped by one of the hands in such a manner that the thumbs outline the course of the ischiopubic rami, while the web of each thumb comes in contact with the corresponding ischial tuberosity and the hollow of the hand holds the buttock (Fig. 583). In this way the outlines of the pubic arch are very satisfactorily indicated by the position of the thumbs, so that with a little practice one can readily determine whether it is normal, narrowed, or very contracted.

If the pubic arch appears to be narrowed, the transverse diameter of the outlet should be measured, and, if it be 8 centimeters or less in length, still other measurements should be made. For the former purpose the regions about both tubera ischii are carefully palpated with the thumbs, and, when the points corresponding to the ends of the transverse diameter have been located, the thumbs are brought into such a position that their nails represent the prolongation of the inner surface of each ischial bone. The distance between the parallel thumb nails is then measured by means of a Budin pelvimeter (Fig. 584), or by a specially devised instrument.

Since 1915, however, I have used almost exclusively the pelvimeter devised by Thoms, which represents a combination of an instrument which I had previously devised and one described by Klien. Thoms' pelvimeter posseses the additional advantage that it also makes possible the measurement of the anterior and posterior sagittal diameters of the outlet, as will be described in the section on funnel pelvis (Fig. 585).

Direct measurement by the means just described is to be preferred to the method described by Schroeder, in which, after carefully palpating the tuberosities, the skin corresponding to their inner margins is marked by means of a dermatographic pencil, and the distance between the two marks is measured. In view of the elasticity of the skin, however, it must frequently happen that considerable distortion will occur as soon as the pressure of the fingers is removed.

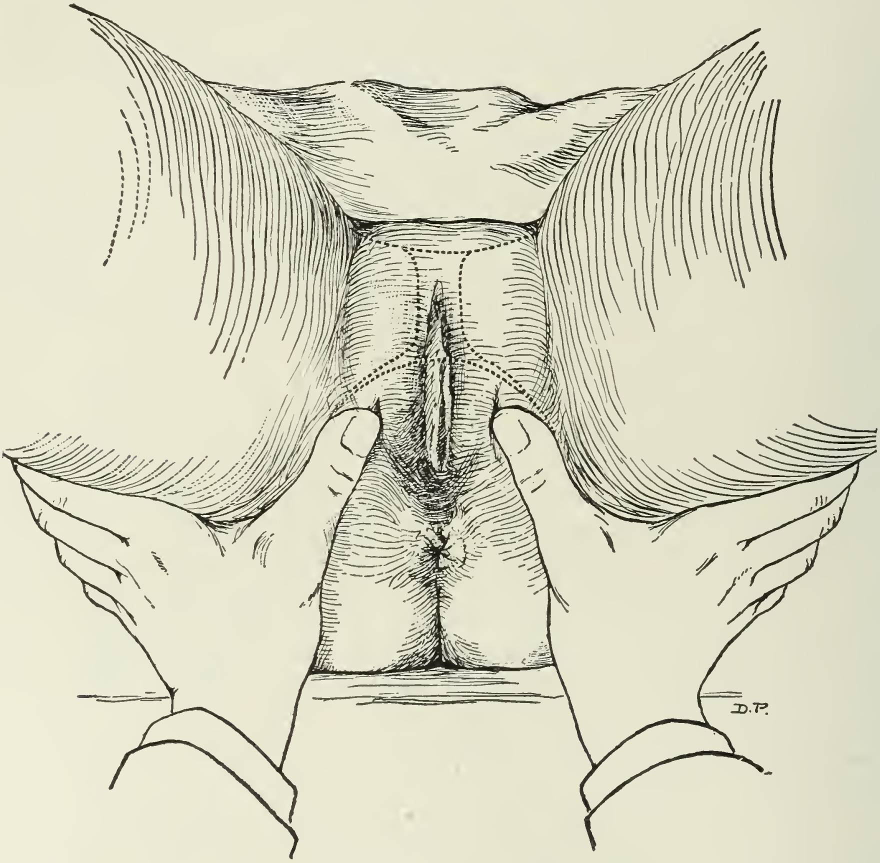

Fig. 583.—Palpation of Pubic Arch.

The anteroposterior diameter, between the lower margin of the symphysis and the tip of the sacrum, is readily measured by a modification of Breisky's method. For this, an examining table provided with a "U"-shaped opening in the center of its lower end is especially convenient, but if such it not available, the woman should be brought so far down upon the table that the lower part of the sacrum overhangs its edge. The tip of the sacrum is located through the skin, one end of the pelvimeter is applied over it, and the other is applied to the lower margin of the symphysis pubis. A deduction of 1 centimeter from this measurement will give a tolerably accurate idea of the length of this diameter (Fig. 586).

Unfortunately, however, this is of but slight practical value in the cases in which information is most particularly desired, for the reason that, when the transverse diameter is markedly shortened, the pubic arch becomes so narrow that it is not available for the passage of the head, so that in extreme cases only a small segment of the occiput can engage between the tubera ischii. Consequently the possibility of its birth will depend not upon the length of the anteroposterior diameter of the outlet, but rather upon the distance available between the line joining the tubera ischii and the tip of the sacrum. This diameter was described by Klien as the posterior sagittal of the outlet, and should be measured whenever the transverse diameter measures 8 centimeters or less. This, however, will be considered in greater detail under the heading of Funnel Pelvis.

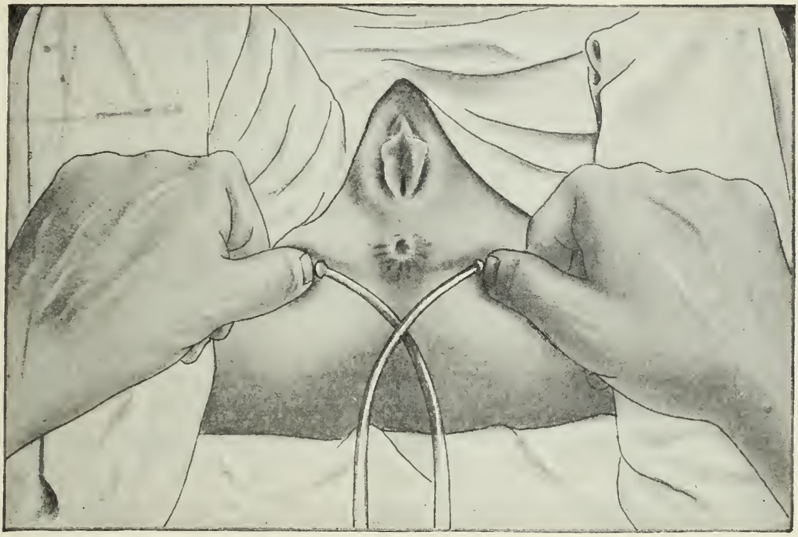

Fig. 584.—Measuring the Distance between the Tubera Ischii.

Use of X-Rays.—After the discovery of the röntgen ray and the demonstration of the various uses to which it might be put, it was thought possible that it might also afford a valuable method of investigating the shape and size of the pelvis. Budin and Varnier, in 1897, reported their experience with it, and showed that, while it often gave an excellent general idea of the shape, the ideas as to size obtained by it were erroneous.

All ordinary radiograms of the pelvis give distorted ideas in regard to its dimensions, owing to the fact that, as the symphysis and promontory of the sacrum lie in different planes, one part of the superior strait is enlarged out of all proportion to the other, according as the picture is taken with the woman lying on her back or abdomen, as the case may be. Such defects make it impossible to attempt to utilize the ordinary radiograph for purposes of mensuration. Bouchacourt suggested that this might be obviated by placing a rectangular metal frame about the woman's hips, more or less corresponding to the plane of the superior strait, each side of the frame being marked by indentations 1 centimeter apart. When the picture is taken these are also reproduced, and upon connecting the corresponding points upon the four sides of the picture a definite idea can be obtained as to the dimensions of the superior strait. This method has been employed by Fabre for years, and has given satisfactory results.

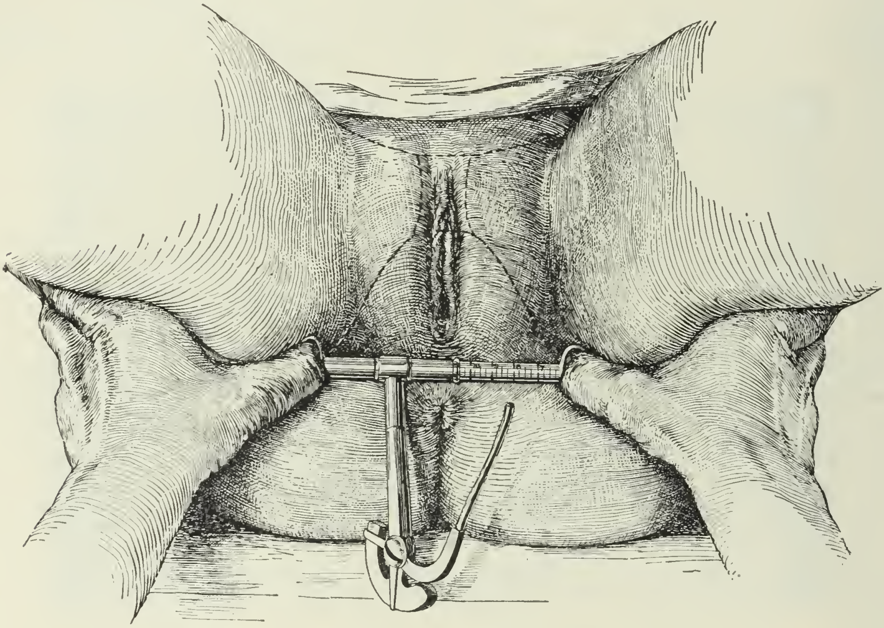

Fig. 585.—Showing Mensuration of Transverse Diameter of Outlet by Means of Thoms' Pelvimeter. × ⅓.

Recently, Thoms in this country and Martius in Germany have devoted especial attention to the subject, and the former has shown that if the patient be placed in such a position that the plane of the superior strait is parallel to the horizon very useful pictures can be obtained. Furthermore, if the height of the top of the symphysis and of the depression beneath the spine of the last lumbar vertebra be measured, and a lead plate perforated at distances of 1 centimeter be placed in the same location and is rephotographed upon the original plate, accurate mensuration becomes possible. But even in this event, the method suffers from the defect that it is not available after the middle of pregnancy, and thus fails to give information when most needed by the obstetrician.

Classification of Contracted Pelves.—For the first classification of abnormal pelves we are indebted to Deventer, who distinguished three groups: too large, too small, and too flat pelves.

Most recent attempts at classification have been based upon the shape of the pelvis, without taking into consideration the etiological factors which lead to its production. This method was adopted by Michaelis, and reached its greatest perfection in Litzmann's hands. The former thoroughly realized its inherent defects and regretted that other methods of classification could not be employed. Kilian, Busch, and Siebold had previously recognized the necessity of taking into account the etiological factors which are concerned, but their knowledge was too meager to permit of such a course.

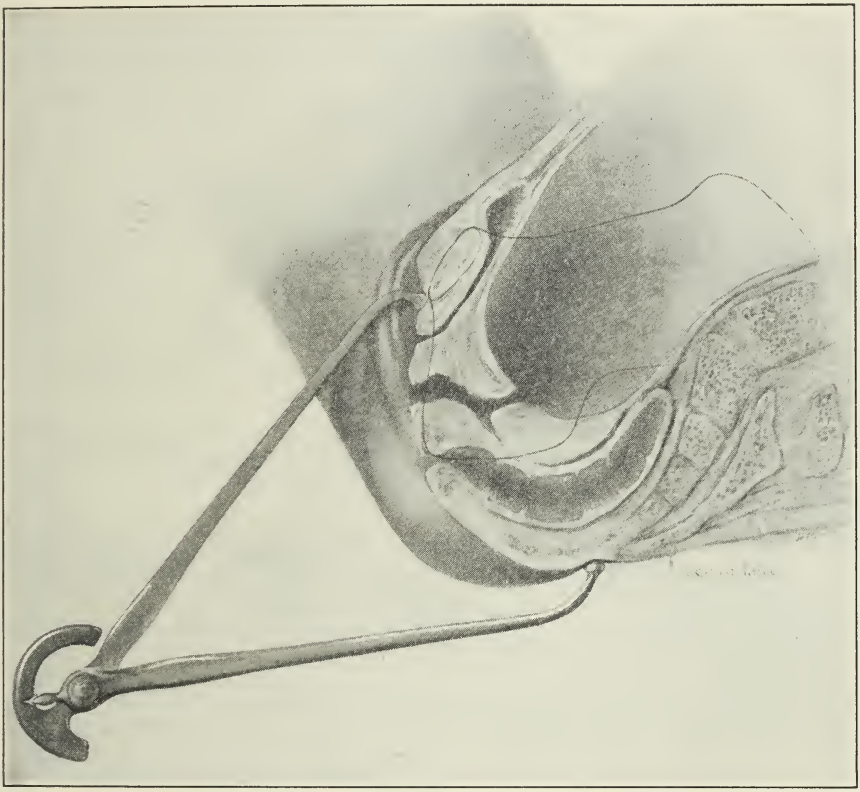

Fig. 586.—Diagram Showing William's Modification of Breisky's Method of Measuring Anteroposterior Diameter of Outlet. × ⅓.

It was not until 1889 that Schauta was able to suggest a fairly satisfactory etiological classification, which soon obtained general acceptance, although it was still far from ideal. Tarnier and Budin, in their treatise issued in 1898, followed somewhat similar lines. Breus and Kolisko do not consider that either is perfectly satisfactory, and have suggested a substitute for them.

Owing to the fact that our knowledge of the fundamental factors underlying the production of many forms of abnormal pelves is still very meager, and occasionally entirely lacking, it is apparent that at the present time no etiological classification can be perfectly satisfactory, though from a practical point of view the one employed by Tarnier and Budin would seem to approach it. In the following chapters I shall employ a combination of that classification with that of Schauta, although I am well aware that it is far from ideal.

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CHAPTER XXXIV

ANOMALIES DUE TO ABNORMAL MALLEABILITY OF THE PELVIC BONES

FLAT NONRACHITIC PELVIS

It is generally held that this is the most usual variety of pelvic deformity occurring in white women, as it was noted in 43 per cent of the contracted pelves described by Michaelis. Litzmann stated that its frequency, as compared with that of the rachitic pelvis, was as 7 to 5. In my experience, however, the funnel and the generally contracted pelvis are the most usual abnormalities in white women, in whom the simple flat pelvis occupies the third place, while it occurs extremely rarely in black women.

The following table gives the relative incidence of the more common types of contracted pelvis in the two races, as observed at the Johns Hopkins Hospital in a series of 11,630 women delivered at full term up to October, 1924—6407 white and 5223 black.

WHITE Order of Frequency	Total No.	Incidence	Percentage of Contracted Pelves	BLACK Order of Frequency	Total No.	Incidence	Percentage of Contracted Pelves
Generally contracted *	345	5.38	39.98	Generally contracted *	1093	20.93	48.86
Funnel, typical †	289	5.03	33.49	Generally contracted rachitic	742	14.21	33.17
Simple flat	156	2.43	18.07	Funnel, typical †	288	6.44	12.87
Generally contracted rachitic	33	0.52	3.82	Flat rachitic	53	1.02	2.37
Atypical	21	0.33	2.43	Simple flat	44	0.84	1.96
Flat rachitic	19	0.30	2.20	Atypical	17	0.29	0.76
TOTAL	863	13.99	99.99	TOTAL	2237	43.73	99.99

* Including generally contracted funnel pelves.
† Measured only after case 2000.

In these 11,630 women the simple flat pelvis occurred in 2.43 per cent of the whites and in 0.84 per cent of the blacks; and, upon omitting the outlet contractions, it represented 27.2 and 2.3 per cent, respectively, of the abnormal pelves in the two races.

Most German authors confirm the statements of Michaelis and Litzmann as to its frequency. On the other hand, Ahlfeld dissented from this view, holding that many of the pelves which have been designated as simple flat are really of rachitic origin, and Tarnier and Budin stated that only one-sixteenth of the abnormal pelves with which they met could be attributed to other causes than rachitis.

This variety is frequently described as the *Pelvis plana deventeri,* or *simple flat pelvis,* although it is doubtful whether Deventer differentiated between it and the rachitic form. It was accurately described by Betschler, in 1832, but Michaelis and Litzmann were the first to insist upon its importance and frequent occurrence.

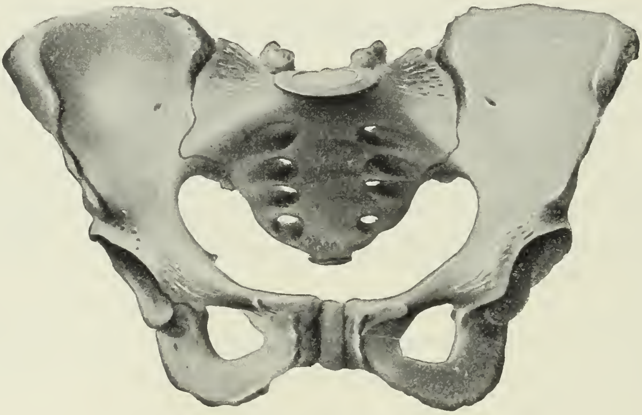

Fig. 587.

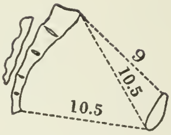

Fig. 588.

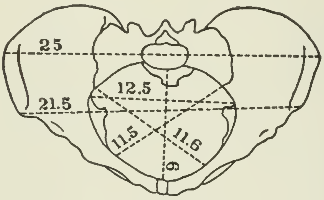

Fig. 589.

Figs. 587-589.—Simple Flat Pelvis.

The characteristic feature of the flat nonrachitic pelvis consists in a shortening of all the anteroposterior diameters of the pelvic cavity, while the transverse measurements remain practically normal.[1] This condition is due to the fact that the entire sacrum approaches more nearly than normal to the symphysis pubis. At the same time it undergoes a slight rotation about its transverse axis, as shown by the fact that the contraction is always more marked in the superior than in the inferior strait. The degree of contraction is usually not very pronounced, and it is rare to find the conjugata vera measuring less than 8 centimeters. In fact, whenever this limit is passed, the probability that one has to deal with a flat rachitic pelvis should always be borne in mind.

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[1] The illustrations in the chapters on Contracted Pelves have been prepared with great care. The half-tone illustrations are exactly one-third natural size, and were drawn from photographs which were taken with the pelves as nearly as possible in the same position—that is, with the tip of the coccyx and upper margin of the symphysis pubis on the same horizontal level. Accordingly, the illustrations can be accurately compared.

The diagrams of the superior strait and the sagittal sections through the pelvic cavity are one-sixth natural size, and are accurate to within 1 millimeter. The former were made by means of the camera with the plane of the superior strait at right angles to the horizon.

The sacrum does not present the characteristic features of rachitis, and preserves its normal vertical and side to side concavity. Occasionally it may appear somewhat more delicately shaped than usual, and be narrower transversely. In such circumstances the transverse diameters of the pelvic cavity are also slightly decreased.

In not a few pelves of this character the line of ossification between the first and second sacral vertebræ is more marked than usual, thus giving rise to a so-called second or accessory promontory.

Etiology.—By many European authorities it is believed that the approach of the sacrum to the symphysis results from the carrying of heavy burdens upon the back or head during early life, though such an explanation cannot apply in this country, where it is unusual for girls to carry such loads. In other cases the condition is attributed to the fact that the child was allowed to sit up at too early an age and for too long periods.

Aschner believes that it is associated with the asthenic constitutional type, and that the flattening of the pelvis is due to the same cause as the flattening of the chest. I do not agree with him, as the majority of my patients with simple flat pelves were robust women with no other stigmata of degeneration. Hirsch contends that this abnormality occurs particularly frequently in textile workers, and is inclined to attribute it to the unusual use of the psoas and gluteal muscles necessitated by tending machines at an early age.

Ahlfeld, Tarnier, and Breus and Kolisko think that a part in the production of the deformity is played by rachitis, which, they hold, may be present in a larval form without giving rise to its usual and characteristic manifestations. The latter state that the shortening of the conjugata vera is not so much due to a rotation of the sacrum as to the shortening of the iliac portion of the terminal length of the innominate bone; and, as they believe that this is usually the result of rachitis, they consider that it aids materially in determining the etiology of the condition.

Fehling and Schliephake consider that this variety of pelvic anomaly is congenital in a certain number of instances, as they have shown that the pelves of newly born children may occasionally present a flattened appearance. In several cases studied by them the relation between the conjugata vera and the transverse diameter of the superior strait was as 100 to 145, 100 to 160, or 100 to 177, instead of 100 to 122, as is usually the case. In such circumstances the mechanical factors above alluded to could certainly not have come into play.

The latter were made from tracings of casts of the pelvic cavity obtained by means of dental wax, and reduced by the pantograph.

Diagnosis.—The presence of a simple flat pelvis, as a rule, is readily detected. By external pelvimetry the distances between the spines and crests of the ilium, as well as between the trochanters, are found to be approximately normal, whereas Baudelocque's diameter is definitely shortened. On internal examination the diagonal conjugate is found to be shortened, though never to an extreme degree. In general, if it falls below 8 centimeters the pelvis does not belong in this category. The entire anterior surface of the sacrum presents the normal curvatures, but appears to be nearer the symphysis than usual. There is no widening of the transverse diameter of the pelvic outlet, as in the rachitic form. The average measurements in 26 of my cases were: spines, 25.7; crests, 27.8; trochanters, 30.5; Baudelocque's diameter, 18; and diagonal conjugate, 10.7 centimeters.

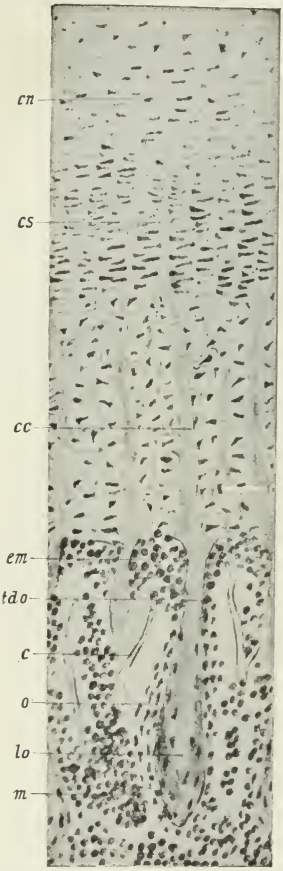

Fig. 590.—Section through Normal Epiphysis of Child (Spillmann).

cn., normal cartilage; *cs.*, cartilage cells arranged in parallel rows; *cc.*, area of preliminary calcification; *em.*, medullary spaces; *o.*, osteoblasts; *lo.*, osseous lamellæ; *m.*, marrow.

RACHITIC PELVIS

In many parts of Europe one of the most prominent factors in the production of contracted pelves is an abnormal softening of the bones in early life resulting from rachitis. In this country pronounced degrees of the disease are observed comparatively rarely in white children, occasionally in colored children inhabiting country districts and very frequently in those living in large cities.

In not a few cases the disease undergoes spontaneous cure, so that no trace of its existence can be discovered in later life; while in many instances permanent skeletal deformities result which are principally localized in the pelvis. Again, it is also not unusual to meet with women who to all appearances are quite normally formed, but whose pelves upon examination present rachitic deformities. Rachitic pelves were noted in 0.82 per cent of the white and 15.83 per cent of the black women in the tables given on page 865. Omitting outlet contractions, they constituted 9 and 40 per cent, respectively, of the abnormal pelves observed in the two races, thus showing that even in this country the disease is of marked importance from an obstetrical standpoint.

Nature and Pathology of Rachitis.—Before describing the various changes in the pelvis which may result from rachitis, it will be well to consider briefly the nature and pathology of the disease.

Unfortunately it is impossible to make clear-cut statements in this regard, more particularly as the work of Schmorl, Recklinghausen, Ogata, and others tends to indicate that the difference between rachitis and osteomalacia is nothing like so marked as was formerly believed. According to Kassowitz, Spillmann, and others, the former is to be looked upon as an osteitis associated with an excessive formation of osteiod tissue at the epiphyses and beneath the periosteum of the long bones, as well as in the flat bones of the skull and pelvis. The proliferation is accompanied by defective calcification of the newly formed tissue, Zweifel stating that only 18 to 24 per cent of inorganic salts are present, as against 63 to 65 per cent in normal bone.

It is customary to distinguish three stages in the disease—congestion, softening, and progressive deformity or cure, as the case may be. In the first stage there is a great increase in vascularity, which is most marked at the union of the articular cartilages with the diaphyses of the long bones as well as beneath the periosteum. In the former location the zone of preliminary calcification—Guérin's line—is slightly thickened, and its lower portion adjacent to the newly formed spongy bone is perforated by numerous vascular loops. A similar condition may also be observed beneath the periosteum covering the long and the flat bones (Fig. 591).

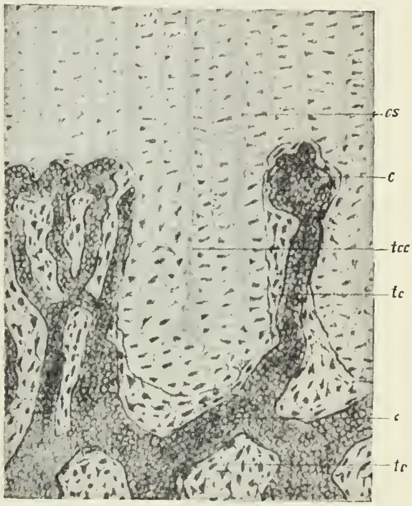

Fig. 591.—Section through Epiphysis in Early Stage of Rachitis (Spillmann).

cs., cartilage cells arranged in parallel rows; *tcc.*, area of preliminary calcification; *c.*, capillary; *tc.*, unossified connective tissue.

In the second stage, while Guérin's line has become markedly thickened and very irregular, the vascular proliferation has advanced to a marked degree. Under the microscope the former is seen to be broken up in all directions by the rapidly growing vascular loops, which subdivide it into large numbers of small irregularly shaped calcific areas. At the same time the formation of osseous tissue just beneath it proceeds in an irregular manner, calcification either failing to occur or taking place imperfectly. In the newly formed tissue, between the vascular loops and the narrow cavities, there is a considerable formation of osteoid tissue, with spindle- and star-shaped cells, which does not become ossified at all.

To summarize these changes briefly, one may say that the growing end of the bone, instead of undergoing normal ossification, consists in great part of dilated capillaries which separate irregularly shaped masses of calcified cartilage from areas of connective tissue and imperfectly formed bone (Fig. 592). Similar changes take place under the periosteum of the long and flat bones, so that the shaft of the bone soon becomes converted into a spongy tissue corresponding closely to that observed at the epiphysis.

In the third period the process continues until death occurs; or, if recovery ensues—the usual outcome—there is a progressive decrease in vascularity, and the normal process of ossification is resumed, so that after a time the only trace of the disease is to be found in an atrophy of the bone, which is frequently associated with thickening and an increased porosity. Consequently, it is apparent that the bones become abnormally soft and yielding in the acute stages of the disease, so that if the child uses its extremities at the time, more or less marked deformity must result, depending upon the effect upon the softened bone of the mechanical factors, which are normally concerned in the production of the form of the infantile pelvis. Breus and Kolisko insist that practically no growth occurs during the acute stage of the disease, and, consequently, if it persists for any length of time, it must inevitably lead to atrophic changes, so that after recovery the bones are smaller and somewhat lighter than normal, even though they show no characteristic signs of deformity.

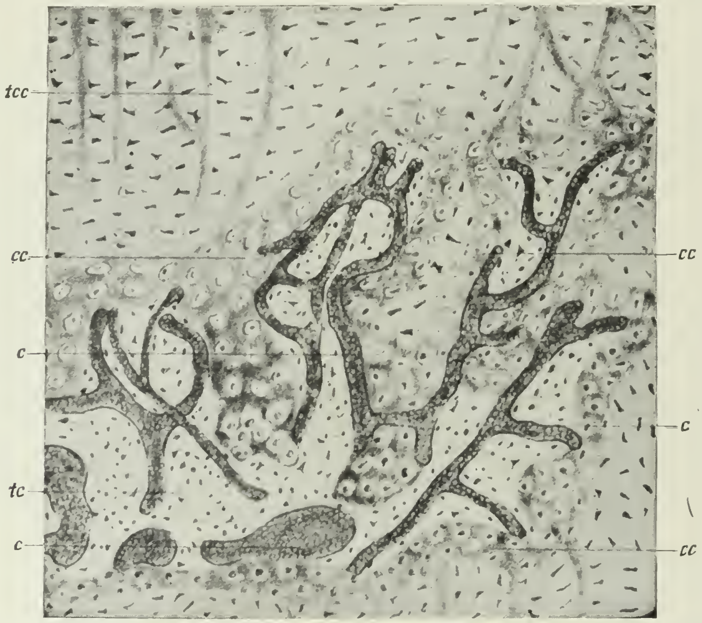

FIG. 592.—SECTION THROUGH EPIPHYSIS IN ADVANCED STAGE OF RACHITIS (Spillmann). *tcc.*, area of preliminary calcification; *cc.*, calcified cartilage; *c.*, capillaries; *tc.*, connective tissue.

Forms of Rachitic Pelvis.—As has already been said, the rachitic type is one of the frequently observed varieties of contracted pelvis, and in extreme cases presents the most marked deformities with which we are familiar, with the exception of those resulting from osteomalacia. Fortunately, however, the degree of contraction is usually not so pronounced, Tarnier having found that the conjugata vera measured less than 8.5 centimeters in only 14.4 per cent of 1020 rachitic pelves.

With the exception of the cases which are complicated by abnormalities of the vertebral column, or by deformities giving rise to a marked difference in the length of the limbs, rachitic pelves are usually classified as follows:

1. Flat rachitic
2. Generally contracted, flat rachitic
3. Generally and equally contracted rachitic
4. Pseudo-osteomalacic

1. *Flat Rachitic Pelvis.*—In this variety the greatest contraction occurs in the anterposterior diameter of the superior strait, while the transverse diameter is normal, or even slightly increased in length. Generally speaking, the pelvic bones are less dense in texture than usual, and frequently are delicate in form, though occasionally they may appear clumsy and swollen. Owing to the marked lordosis, which frequently results from rachitis, the pelvic inclination, as a rule, is considerably increased.

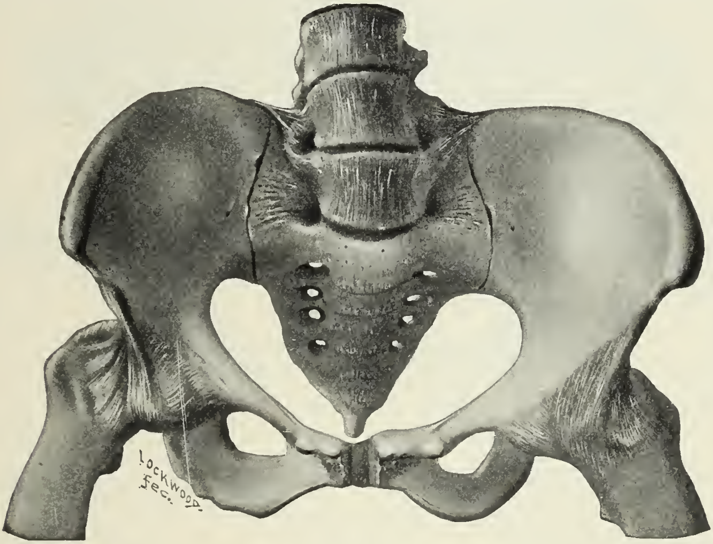

Fig. 593.

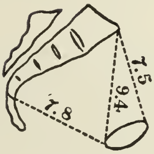

Fig. 594.

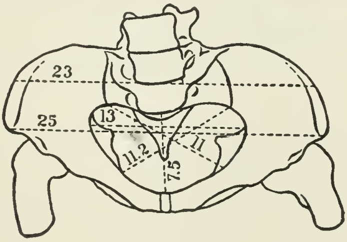

Fig. 595.

Figs. 593-595.—Flat Rachitic Pelvis.

Most important changes are to be noted in the sacrum, which differs from the normal in that it is broader and less concave from side to side, thinner from behind forward and shorter from above downward. The longitudinal axis of the bone is so altered as to form a greater angle with the conjugata vera, and consequently the promontory lies at a lower level than usual, approaches the symphysis pubis, and encroaches markedly upon the area of the superior strait. Usually the entire sacrum is sharply bent upon itself in the neighborhood of its third vertebra, so that its vertical concavity becomes markedly accentuated. At the same time the bodies of the individual vertebræ extend out beyond the level of their alæ, thereby diminishing the lateral concavity of the sacrum, and generally converting it into a pronounced convexity. In the latter event the spinous processes project less far than usual beyond the posterior surface, which tends to become concave. Occasionally, however, the increase in vertical concavity does not occur, and in such cases the sacrum may be quite straight from base to tip.

As the upper part of the sacrum becomes displaced downward and forward, its posterior surface recedes from the superior posterior spines of the ilium, which approach one another more closely than in the normal condition, so that the posterior limb of the S-shaped curvature of the iliac crests becomes accentuated.

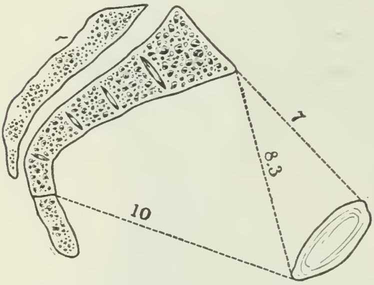

Fig. 596.—Usual Accentuation of Vertical Concavity of Sacrum in Rachitis.

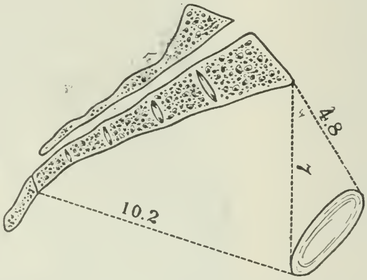

Fig. 597.—Less Common Obliteration of Vertical Concavity of Sacrum in Rachitis.

Occasionally the anterior surface of the sacrum may be convex in both directions, and, when directed more vertically than usual, it may happen that the greatest convexity will correspond to the region of the second and third sacral vertebræ. In this event the shortest diameter of the pelvis will be the anteroposterior of the plane of greatest pelvic dimensions, instead of the conjugata vera. Breus and Kolisko have classified such pelves in a special group, and designate them as "middle flat." In such cases the promontory of the sacrum is not displaced downward, and the condition is usually associated with assimilation.

Occasionally the body of the first sacral vertebra is displaced further forward than those below it, so that its lower margin projects beyond the general surface, and can be felt as a *false,* or double *promontory.* In such circumstances the distance between it and the symphysis pubis may be shorter than the conjugata vera. The presence of a false promontory is usually indicative of the assimilation of an extra vertebra to the sacrum, and its significance will be discussed when assimilation pelves are considered.

The iliac bones are smaller and frequently more delicately shaped than usual, the vertical height of the pelvis as well as the length of the iliac crests being diminished. The iliac fossæ are more concave, and frequently present a pronounced, sharp depression just in front of the sacro-iliac joint. As a result the anterior margin of the bone extends more vertically than usual, as is shown by comparing the slant of the line joining the acetabulum and the anterior superior spine of the ilium. At the same time the anterior portion of the bone flares out at the expense of the crest, so that the distance between the anterior superior spines approaches and occasionally even exceeds, that between the crests.

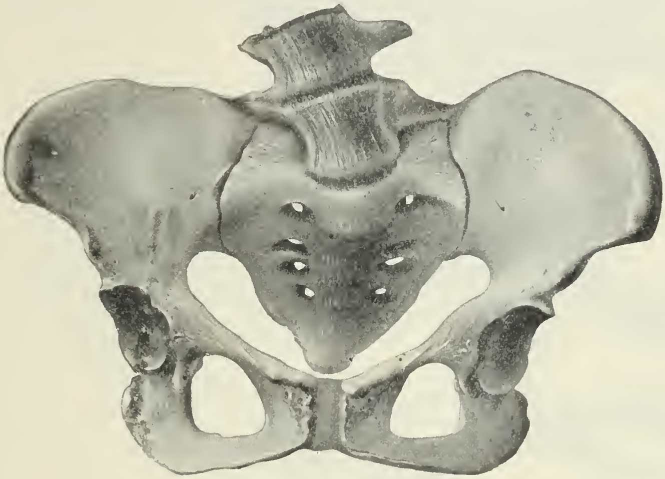

Fig. 598.

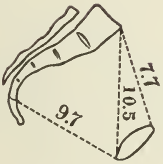

Fig. 599.

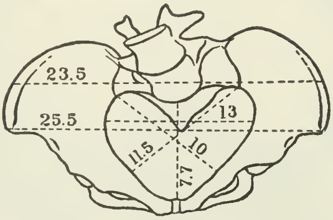

Fig. 600.

Figs. 598-600.—Flat Rachitic Pelvis, Showing Double Promontory.

The diminution in the size of each iliac bone is best appreciated by studying its "terminal length" (Figs. 24 and 25). Normally, its three component parts are practically of the same length, but in rachitis the pubic portion retains its normal dimensions, the sacral portion is slightly shorter than usual, while the iliac portion is greatly shortened, and occasionally presents only a fraction of its normal length. Breus and Kolisko consider this change almost pathognomonic of rachitis.

In many cases the iliac bones bend just in front of the sacro-iliac synchondrosis, so that the iliopectineal line, instead of following a gentle curve, forms a sharp angle at that point, thus adding materially to the flattening of the superior strait. At the same time the acetabula are displaced forward, and thus come to lie upon the anterior instead of upon the lateral portion of the pelvic ring.

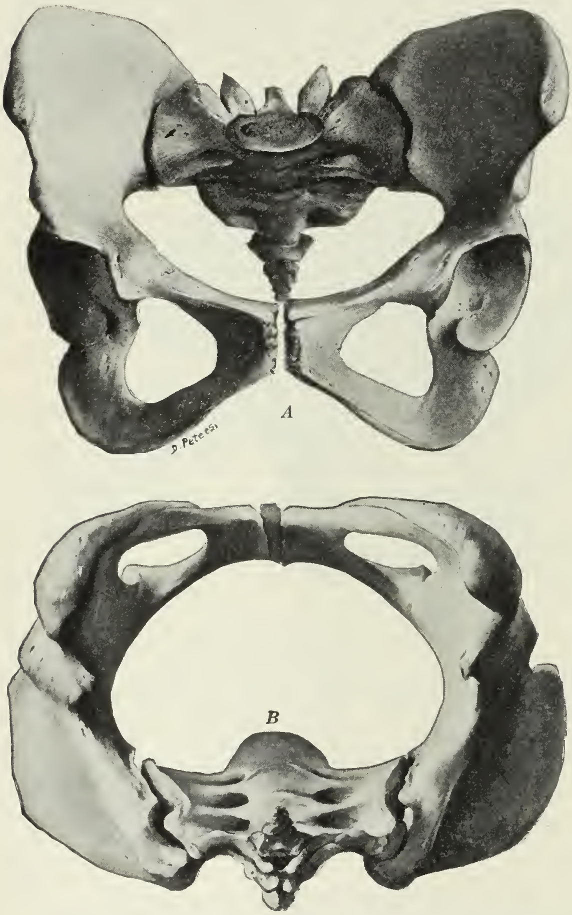

Fig. 601.—Generally Contracted Rachitic Assimilation Pelvis.

A, anterior view; *B,* inferior view showing relative widening of outlet.

The pubic arch is relatively, and sometimes actually, wider than normal, and the tubera ischii may be so everted that the transverse diameter of the outlet appears to be exaggerated. Seuffert, on the other hand, has pointed out that this tendency may be completely neutralized when the sacrum shows signs of high assimilation, so that the dimensions of the outlet become actually reduced. In view of the upward and backward dislocation of the tip of the sacrum, the anteroposterior diameter of the outlet is also either relatively or absolutely increased in length. Consequently, in contrast with the flattened superior strait, the pelvic outlet appears wide and gaping, and in extreme cases may be nearly twice as roomy as the inlet (Fig. 601, *A* and *B*).

According to the degree of displacement of the promontory of the sacrum a decided influence is exerted upon the shape of the pelvic cavity, the effect being most marked in the superior strait, which may become oval, reniform, or even heart-shaped in outline. The conjugata vera is always shortened, while the transverse diameter seems to be enlarged, although this is usually only relative. Owing to the approach of the anterior and posterior walls of the pelvis, the oblique diameters of the superior strait are always shortened, as are also the sacrocotyloid diameters.

In occasional cases sharp exostoses may make their appearance upon the pubic crests, upon the ilopectineal eminences, or in front of the sacro-iliac synchondroses—*pelvis spinosa*. When such structures are not well covered by soft parts, they may lead to injury of the uterus at the time of labor.

2. *Generally Contracted, Rachitic Pelvis.*—It is in this variety of pelvis that extreme degrees of contraction are often encountered, the conjugata vera sometimes being reduced to 3 or 4 centimeters. This pelvis corresponds closely to the ordinary flat rachitic type, except that the entire structure is smaller, and its component parts are lighter in build than usual. As a result, the shortening applies to all of its diameters instead of being limited to the conjugata vera. At the same time, the outlet usually appears abnormally large when compared with the inlet, notwithstanding the fact that all of the diameters of the former actually fall felow the normal limits (Fig. 601).

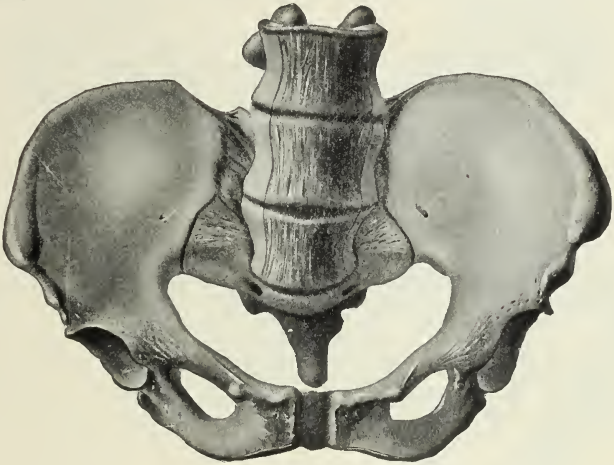

Fig. 602.

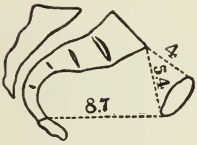

Fig. 603.

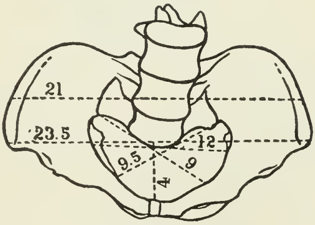

Fig. 604.

Figs. 602-604.—Generally Contracted, Flat Rachitic Pelvis.

The various component parts of the pelvis show a relative decrease in size, particularly marked in the sacrum, which may present a considerable diminution in its transverse measurements. The generally reduced size of the pelvis in such cases may be due either to trophic changes in the bones resulting from the rachitis itself, or to the fact that the environmental tendencies controlling its development would have given rise to an abnormally small pelvis quite independently of the complicating disease.

3. *Generally Equally Contracted Rachitic Pelvis.*—This variety was first described by Michaelis, and according to most authors is observed but rarely. Müller, however, considers that not a few cases which were previously described as instances of simple, generally contracted (justo minor) pelvis belong in this category, and my own experience, particularly in the Negro, confirms his observations.

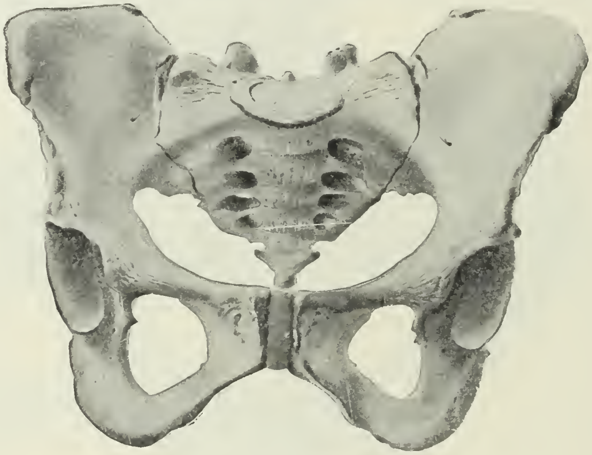

Fig. 605.

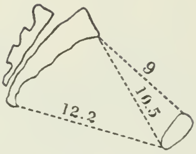

Fig. 606.

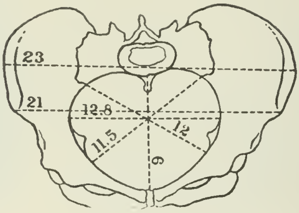

Fig. 607.

Figs. 605-607.—Generally Equally Contracted Rachitic Pelvis.

According to Litzmann, this type differs from the justo minor pelvis in its ungainly and angular appearance, and in the marked prominence of the pubic crests. The superior strait appears to be equally shortened in all its diameters instead of merely flattened, while the rest of the pelvis presents indisputable signs of a past rachitis, which is more particularly marked in the sacrum and in the eversion of the tubera ischii.

4. *Pseudo-osteomalacic Rachitic Pelvis.*—This variety is a manifestation of the severest form of rachitis, and is associated with the most marked degrees of contraction. As the name implies, the pelvis resembles one deformed by

osteomalacia, the sacrum and lateral walls approaching one another so as to give rise to a very small, trefoil-like superior strait, the contraction also extending to other portions of the pelvic cavity. Such pelves, however, are readily differentiated from the true osteomalacic type, since the sacrum and innominate bones present characteristic rachitic deformities.

This form of pelvis was first described by Smellie, who depicted it in his anatomical plates. More particular attention was directed to it by Stein, and especially by Naegele. It is not of frequent occurrence, though Fasbender, in 1878, was able to collect 40 cases from the literature, not a few of which occurred in young children.

Diagnosis of Rachitic Pelvis.—Important information as to the presence of rachitis may be elicited by inspection of the patient, when characteristic deformities may be noted about the head, vertebral column, and lower extremities. In not a few cases the presence of thickened epiphyses at the costal margins—the so-called rachitic rosary—may also serve to call attention to the existence of the disease.

A decidedly pendulous abdomen in primiparous women is always suggestive of marked disproportion between the size of the head and the pelvis, and should suggest a search for rachitic changes.

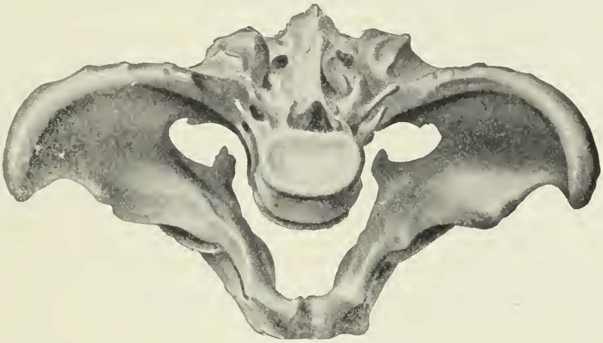

FIG. 608.—PSEUDO-OSTEOMALACIC PELVIS (Naegele).

The age at which the patient first learned to walk is also of considerable importance, as it is well known that children suffering from rachitis are usually backward in this respect. Again, when the disease appears after the first year of life, the child usually ceases to walk during its acute stages, and has to learn again at a later period.

Accurate information concerning the pelvis, however, can be obtained only by pelvimetry. On external mensuration the distances between the spines and crests of the ilium no longer show their normal relations, but the former approach, and frequently exceed, the latter in length. Normally, there is a difference of 2.5 centimeters between the two, and whenever this becomes reduced to 1 centimeter or less rachitis should be suspected. The distance between the trochanters will be normal or not according as one has to deal with the flat or the generally contracted type. Baudelocque's diameter is always considerably shortened. At the same time Michaelis' rhomboid loses its regular outlines, and in pronounced cases, owing to the sinking downward and forward of the sacrum, becomes converted into triangular area. The pubic arch is usually widened, and the transverse diameter of the outlet is either relatively or absolutely increased.

Still more definite information may be gained by internal pelvimetry and palpation of the pelvic cavity. The diagonal conjugate is always shortened. The anterior surface of the sacrum is more readily accessible to the examining fingers, and on palpation its upper portion is found to be flatter than usual, and ordinarily is convex from side to side owing to the protrusion of the vertebral bodies beyond the alæ; at the same time its lower portion is sharply bent forward. In other words, the normal vertical concavity of the anterior surface of the sacrum becomes accentuated, while its lateral concavity becomes decreased, or is even converted into a convexity.

The average measurements in ten rachitic pelves in white women were: Spines, 25.4; crests, 25.7; trochanters, 29.3; Baudelocque, 17; and diagonal conjugate, 10.1 centimeters; while in 79 colored women the measurements averaged: Spines, 23.7; crests, 24.4; trochanters, 28.6; Baudelocque, 17.3; and diagonal conjugate, 10.6 centimeters.

The difference in the measurements between the spines and crests in the two races is due to the lesser flaring of the iliac bones and to the generally smaller size of the pelvis in colored women. Thus, in two series of 707 and 470 normal pelves, respectively, the spines and crests measured 25.5 and 28 centimeters in white, as compared with 24 and 26 centimeters in colored women.

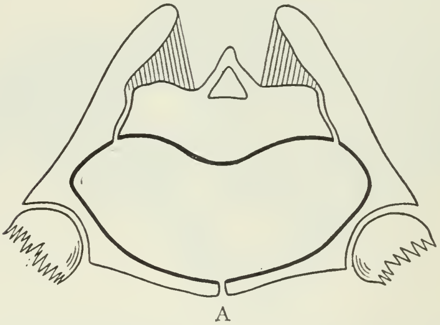

Fig. 609.—Diagrams Showing Changes in Shape in (A) Rachitic and (B) Osteomalacic Pelves (Schroeder).

The flat rachitic pelvis is diagnosticated when the transverse external measurements show but slight diminution, whereas in the generally contracted variety they are definitely shortened. In practice, the generally and equally contracted variety is usually confounded with the generally contracted rachitic type, and a correct diagnosis is not made unless the dried pelvis becomes available; while the characteristic deformity of the pseudo-steomalacic form will be recognized on internal examination, and the decision as to whether it is due to rachitis or osteomalacia will be determined by the history of the patient, as well as by the detection of definite rachitic deformities.

Mode of Production of the Rachitic Deformities.—In Chapter I, we considered the part played by various mechanical factors in the transformation of the fœtal into the adult pelvis. Prior to the work of Breus and Kolisko, it was generally believed that abnormalities and variations in their mode of action upon the softened pelvis served to explain satisfactorily the production of most of the characteristic rachitic deformities. This doctrine was developed in great part by Litzmann and Schroeder, and obtained almost general acceptance. According to their theory, as the young child in the acute stages of rachitis is unable to walk, and spends its time in a sitting or reclining position, the upward and inward force exerted by the femora is in abeyance. Consequently, the body weight and the cohesive force at the symphysis pubis are the only forces which come into play, and when the former is transmitted by the vertebral column to the sacrum it is resolved into two forces—one directed downward and the other forward. As a result, the sacrum rotates about its transverse axis, the promontory being pressed forward and downward, while the remainder of the bone moves in the opposite direction and tends to assume a more horizontal position. The extreme upward dislocation of its lower end is resisted by the traction exerted upon it and upon the coccyx by the strong sacrosciatic ligaments, and consequently the softened bone becomes sharply flexed at its lower portion, whereby its vertical concavity is accentuated. At the same time, owing to the softened condition of the sacrum and the imperfect union between the bodies and alæ of its vertebræ, the former are pushed out beyond the latter, thereby converting its normal lateral concavity into a convexity.

As the promontory becomes displaced forward and downward under the influence of the body weight, the posterior surface of the sacrum recedes from the superior posterior spines of the ilium, thus subjecting the strong iliosacral ligaments to marked tension. As a result, the posterior iliac spines are drawn nearer to the middle line, while at the same time the anterior portions of the iliac bones flare out, thus accounting for the changed position of the anterior superior spines. This movement is resisted by the cohesive force exerted at the symphysis pubis, and as a consequence the softened ilia bend just in front of the sacro-iliac synchondrosis, so that the iliopectineal line on either side, instead of following a gentle curve, becomes sharply bent at that point.

Coincident with these changes, the positions of the acetabula become altered, and eventually come to be situated upon the anterior, instead of upon the lateral, walls of the pelvis. As a result, when the child begins to walk, the forces exerted by the femora also add to the flattening of the superior strait. On the other hand, owing to the previous nonuse of the lower extremities, these last forces have not been called into play early enough to counteract the widening of the pelvic outlet as a result of prolonged sitting, and consequently the ischial tuberosities remain flared out.

The same factors are concerned in the production of the generally contracted rachitic pelvis, its small size being due either to atrophy incident to rachitis, or to the effect of the disease upon a pelvis already abnormally small.

The pseudo-osteomalacic form results when the rachitic softening of the bones is very marked and the child persists in walking. In such circumstances not only do the characteristic changes in the sacrum and iliac crests develop, but at the same time the entire pelvis, being caught between the downward force exerted by the vertebral column and the upward and internal force exerted by the femora, tends to collapse, so that in extreme cases the pelvic cavity becomes almost obliterated.

This mechanical doctrine was early opposed by Fehling, Freund, Kehrer, and others. The former held that the characteristic form of the pelvis might result *in utero,* from fœtal rachitis, before the various mechanical factors could come into play. Such a view, however, is no longer tenable; for, following the researches of Porak, and Kaufmann, it has been established that this disease has nothing in common with true rachitis, but is a distinct entity, which has been variously designated as achondroplasia, or chondrodystrophia fœtalis.

Freund has attempted to show that in view of the peculiar nature of the sacro-iliac joints the sacrum cannot rotate about its transverse axis. His argument, however, appears to have been based in great part upon conditions observed in adult life, and he seems to have lost sight of the fact that the articular surfaces in early life are almost entirely cartilaginous, and thus readily permit of motion in any direction.

Kehrer believed that the action of certain groups of muscles plays an important part in the production of abnormal pelves. No doubt this is true to a certain extent, but it is hardly probable that it is the only factor concerned.

On the other hand, Breus and Kolisko claim that the mechanical views of Litzmann and Schroeder are in great part erroneous, as they hold that most rachitic deformities can be explained without invoking the intervention of mechanical forces. They have shown that rachitis not only gives rise to a general softening of the pelvic bones but manifests itself more particularly in the imperfect development of the ilium and sacrum. Consequently, they contend that the flattening of the superior strait is in great part due to the imperfect growth of the iliac portion of the innominate bone, while the pubic and sacral portions are but little affected. Such an abnormality must inevitably lead to the shortening of the anteroposterior diameter, while, as the result of the normal development of the pubic portion, the transverse diameter will become relatively lengthened.

Moreover, they hold that the displacement of the sacrum is not due to rotation about its transverse axis, but rather to the fact that the lack of development at the sacral end of the iliac portion of the innominate bone interferes with the normal backward displacement of the sacro-iliac joint. At the same time they are willing to admit that the changes in the curvatures of the sacrum may be due to the action of purely mechanical factors.

While the investigations of Breus and Kolisko have thrown great light upon the mode of production of rachitic deformities of the pelvis, I do not believe that they should be accepted as the only explanation. Accordingly, it would seem that three factors are concerned in the genesis of these deformities: (1) abnormalities in the development of the rachitic bones; (2) the mechanical action of the various forces upon the softened bones; and (3) the traction or compression exerted by various muscles and ligaments.

OSTEOMALACIC PELVES

Inasmuch as osteomalacia gives rise to the most marked pelvic deformities with which we are familiar, it was only natural that the attention of obstetricians should have been directed to it at an early date. Cooper performed cesarean section for this condition in 1768, but for the main pioneer work we are indebted to Stein, Kilian, and Litzmann.

Nature and Clinical History of Osteomalacia.—Osteomalacia, halisteresis, mollities ossium, or malacosteon disease is a general constitutional disorder, probably dependent upon some as yet unknown perversion of the internal secreory organs, which manifests itself by neuritic changes, muscular atrophies, and particularly by characteristic changes in the bones, which become soft, yielding, and occasionally brittle, and consequently undergo marked changes in shape as the result of the action of the various mechanical forces to which they are subjected.

The disease is one of adult life, and is very rarely met with in children. It occurs far more frequently in women than in men, especially during pregnancy or the puerperium. Litzmann, in 1861, collected 131 cases from the literature, 85 of which were in pregnant or puerperal women, 35 in nonpregnant women, and 11 in men. Since that time the number of cases in women has markedly increased, whereas in 1900, Hahn was able to add only 31 additional instances in males.

The disease may occur in any part of the world, but is especially frequent, and may even be said to be endemic, in certain localities, notably in the Rhine Valley, the Ergolz Valley in Switzerland, the Olona Valley and Calabria in Italy, in the city of Vienna, and according to Maxwell and Miles in North China. It is very rarely observed in this country, England, or France, Dock having been able to collect only 10 cases in America up to 1896. Tarnier, in his large experience, encountered only 3 cases in Paris, and I have seen the same number in Baltimore.

Unless we are prepared to accept the bacterial origin of the disease, as urged by Arcangeli and other Italian investigators, no satisfactory explanation for its endemic occurrence has been adduced, but it seems to be intimately connected with unsanitary surroundings and inferior food. This was strikingly illustrated by the experience of Winckel, Sr., in Gummersbach in Germany, and of Hoebecke in Sottegem in Holland. The former performed 13 and the latter 14 cesarean sections upon osteomalacic patients, prior to 1840. Since that time improvement in the hygienic conditions of both villages, together with more healthy occupation for their inhabitants, has led to an almost total disappearance of the disease. On the other hand, it may suddenly become endemic in localities in which it was previously unknown, as was illustrated by Ogata's experience in the province of Toyama in Japan. Likewise, a striking increase in its incidence was noted in Vienna apparently as the result of the privations incidental to the World War, and Schlesinger states that it especially affected elderly men. Maxwell and Miles noted it in 1 to 3 per cent of the women in North China and consider it a diet deficiency disease probably due to a lack of fat-soluble vitamins and possibly of calcium itself.

Osteomalacia may affect any portion of the skeleton, but seems to select more particularly the pelvis, vertebræ, and ribs. The fresh bones are yellowish or yellowish-brown in appearance, and very soft and brittle. In advanced cases their consistence is that of leather or wax, so that they can readily be cut with a knife. In the later stages of the disease the spongy bones present a markedly areolated appearance on section, and in some instances are so rarefied that only the outer layers remain intact. At the same time they become much lighter, the specific gravity being frequently reduced by one half.

Under the microscope the marrow spaces are found to be greatly enlarged, and there is a marked increase in vascularity. The most important change, however, consists in the substitution of osteoid tissue in place of the true bone surrounding the haversian canals.

All of the earlier writers upon the subject considered that the changes in the bone resulted from decalcification, which was due to the presence of lactic or a related acid in the circulating blood. But, after the correctness of this view had been denied by Virchow, in 1852, the writers upon the subject became divided into two camps: the one claiming that the essential feature of the disease is decalcification and the other, a disturbance in the relation between resorption and apposition, by which osteoid instead of osseous tissue is formed. Formerly, it was thought that the bone lesions in rachitis and osteomalacia could be readily differentiated, but Recklinghausen, who was formerly a pronounced dualist, stated in his monumental work that it was practically out of the question. Full details of this discussion are to be found in the writings of Gelpke, Winckel, Laufer, Dibbelt, Marquis, and Christofoletti.

One of the most important contributions to the subject was made by Fehling, in 1888, who advanced the theory that the disease was a trophoneurosis of ovarian origin. He believed that characteristic changes could be made out in the ovaries, that these gave rise to reflex stimulation of the vasodilators supplying the bones, and that cure could be effected by removal of the ovaries. Although the various investigators, who have studied those organs histologically have been unable to demonstrate the existence of characteristic lesions, which were thoroughly reviewed by Frazer in 1927, it seems highly probable that the disease is in some way associated with ovarian hyperfunction; otherwise it would be very difficult to comprehend the results which follow castration, as Seitz reports that 87 per cent of 328 patients were definitely cured by the operation. Benzel, in 1919, analyzed the results obtained in the Strassburg clinic, and stated that while cure occasionally followed the administration of adrenalin or the use of x-rays the most brilliant results were obtained by castration. On the other hand, Maxwell and Miles believe that the ovaries play little if any part, as they were able to cure their Chinese patients by the administration of cod liver oil and calcium lactate.

It is not yet known whether the disease results from a primary disturbance of the internal secretion of the ovaries, or whether the latter is a manifestation of hypofunction on the part of the adrenals. A certain amount of evidence in favor of the latter view is afforded by the favorable results obtained by the administration of adrenalin, as recommended by Bossi. It appears that osteomalacic women can take with impunity quantities of the drug, which would give rise to serious symptoms under other conditions, and that its prolonged administration is followed by cure in about one-quarter of the cases. Furthermore, Varaldo states that its use is followed by the appearance of definitely degenerative changes in the ovaries.

More important, from a practical standpoint, is the clinical history of the affection. In its earliest stages it is characterized by peculiar muscular palsies, which more especially affect the iliopsoas, and which are often accompanied by contractures of the abductor muscles of the thigh and by increased patellar reflexes. A little later rheumatoid pains make their appearance in various portions of the body, and at the same time the pelvis, ribs, and vertebral column become very sensitive upon pressure. As the disease advances still further and the bones become softer, various deformities appear, which are particularly marked in the vertebral column and pelvis.

The history of many osteomalacic patients is usually characteristic: The multiparous woman complains of muscular symptoms and rheumatoid pains during pregnancy. The same symptoms recur with added intensity in the succeeding pregnancy, and labor becomes more difficult. Should pregnancy again occur, the rheumatoid pains become severe and locomotion is so interfered with that for the last months the patient is obliged to take to her bed, and craniotomy or cesarean section is usually necessary at the time of labor. Shortly after delivery the pains disappear, and when the patient is able to get about again she notices that she has become some inches shorter than previously, the diminution in stature being sometimes associated with kyphotic changes in the vertebral column.

To sum up, a history of rheumatoid pains and difficult locomotion requiring rest in bed during pregnancy, associated with a decrease in height, is almost pathognomonic of osteomalacia.

Changes in the Shape of the Pelvis.—The extent of the deformity resulting from osteomalacia depends entirely upon the degree of softening which the various pelvic bones have undergone. According to Kehrer, in the early stages of the disease the pelvis is simply flattened as the result of the forcing downward and forward of the promontory of the sacrum.

In the later stages of the disease, when the bones have become very soft, the pelvis takes on a characteristic compressed appearance. The body weight presses the promontory still further downward and forward, while the upward and inward force exerted by the femora pushes the lateral walls of the pelvis inward, so that the superior strait assumes a trefoil appearance, and in extreme cases becomes almost entirely obliterated. At the same time the ischiopubic rami are approximated, and the pubic arch is converted into a narrow slit into which it is sometimes impossible to insinuate the fingers. The pubic rami are pushed markedly forward, giving rise to a beaklike protuberance upon the anterior wall of the pelvis. Coincident with these changes, there is a marked diminution in the size of the pelvic cavity and of the inferior strait, though in not a few cases owing to constant sitting upon the softened bones, the tubera ischii are relatively flared out. In advanced cases the very deformed pelvis may present any one of an almost infinite variety of bizarre shapes.

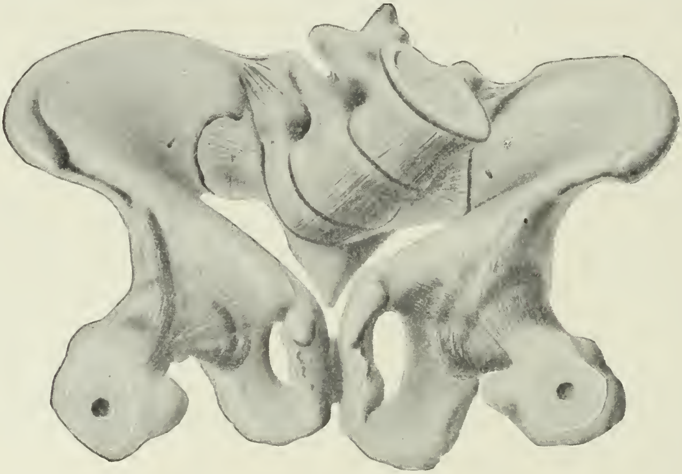

Fig. 610.

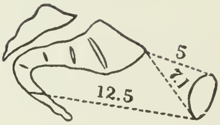

Fig. 611.

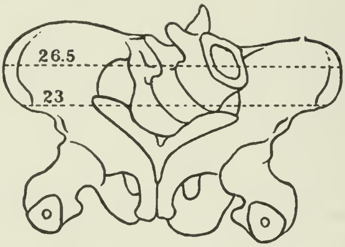

Fig. 612.

Figs. 610-612.—Osteomalacic Pelvis.

Diagnosis.—The diagnosis is readily made, as careful inquiry will usually elicit the characteristic clinical history of the disease; while examination of the pelvis will show that it is markedly compressed in all directions, and the pathognomonic changes in the pubic arch can hardly escape detection. Indeed, the only form of pelvis with which it might be confounded is the very rare transversely contracted Robert pelvis, but the clinical history and the lack of anteroposterior shortening in the latter will usually enable one to differentiate between them.

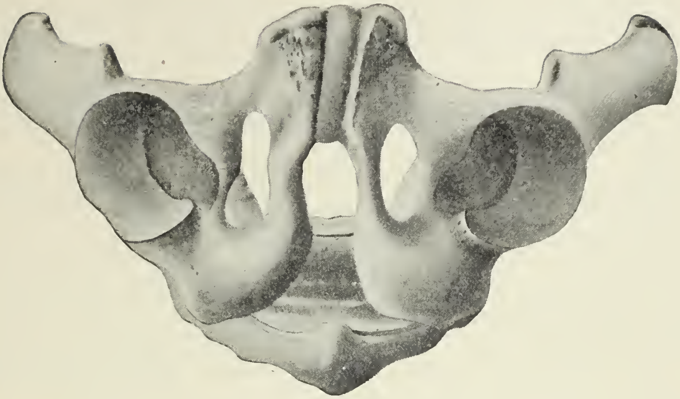

FIG. 613.—OSTEOMALACIC PELVIS, INFERIOR STRAIT.

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CHAPTER XXXV

ABNORMAL PELVES RESULTING FROM PRIMARY ANOMALIES IN DEVELOPMENT

Three separate groups of cases are differentiated according as the abnormalities are: (1) Generalized and symmetrical; (2) localized and asymmetrical; (3) localized and symmetrical.

I. GENERALIZED AND SYMMETRICAL ANOMALIES IN DEVELOPMENT

Abnormal development may manifest itself in an excess or in a lack of the general growth of the pelvis. In the former case we have to do with the generally enlarged or justo-major pelvis, and in the latter with one of several varieties—the generally contracted (justo-minor) pelvis, the infantile, the masculine, or the dwarf type.

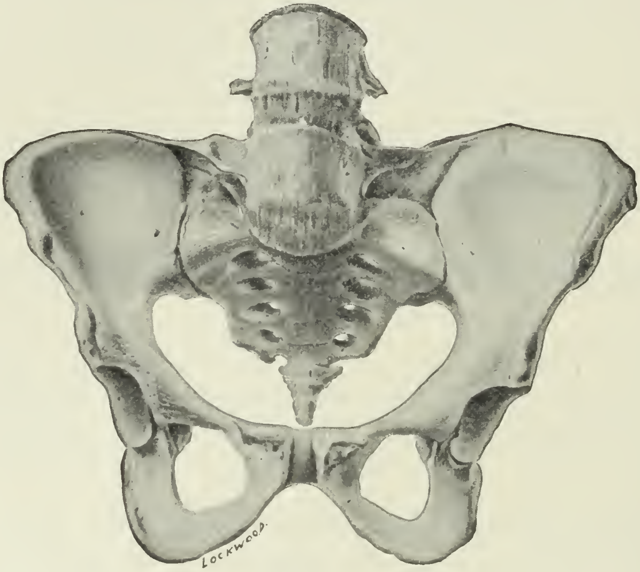
The Generally Enlarged (Justo-Major) Pelvis.—This variety of pelvis is symmetrically enlarged in all its parts, and differs from the normal only by its increased size. It is usually observed in giantesses, and occasionally in women of normal stature; indeed, if the external measurements alone are taken as a criterion, it is of quite frequent occurrence in the latter.

According to Schauta, the various diameters in this type rarely exceed the normal by more than 2 centimeters, though he refers to De la Tourette's case, in which the anteroposterior and transverse diameters of the superior and inferior straits measured 14.9 and 17, and 14.9 and 14.9 centimeters, respectively. In not a few cases the greatest increase is in the anteroposterior diameter, while the others remain practically normal. Occasionally the enlargement may be limited to the superior strait, while the lower portions of the pelvic canal retain their usual proportions, thus producing a funnel-shaped pelvis. In rare instances excessive external transverse measurements may be due to the fact that the fossa joins the main body of the iliac bones at a less obtuse angle than usual.

This variety of pelvis has no effect upon the course of labor, except that its excessive size now and again obviates the necessity for the usual mechanism, and consequently the head may be born so rapidly and suddenly that extensive perineal tears result.

The Generally Contracted (Justo-Minor) Pelvis.—This type was first described by Deventer as the *pelvis nimis parva,* while Stein later applied to it the designation *justo minor.* All of its measurements are more or less proportionately shortened, so that at first glance the pelvis may appear perfectly normal, the narrowing being discovered only after mensuration.

As a rule, the generally contracted pelvis is lighter in texture, and its component parts are more delicately formed than usual. The sacrum is smaller, the alæ are proportionately shorter than the bodies of its vertebræ, and the curvatures of its anterior surface are normal, although the vertical concavity is sometimes increased. On careful examination it is found that the decrease in size is not uniform, as occasionally the conjugata vera is relatively shorter than the transverse diameter of the superior strait, while in every fifth or sixth specimen the inferior is relatively smaller than the superior strait, so that we have a type approaching the simple flat or funnel-shaped pelvis, respectively. Michaelis considered that the anteroposterior shortening in this class of pelves rarely exceeds 1.5 centimeter; and, although this appears to be too conservative a figure, it may be said that whenever the conjugata vera measures 8 centimeters rachitic changes should be suspected.



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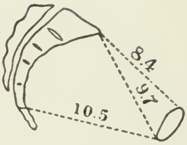

Fig. 615.

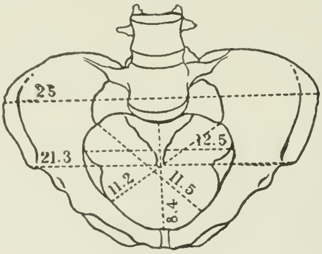

Fig. 616.

Figs. 614-616.—Generally Contracted Pelvis.

This pelvis is usually met with in small women, although one is occasionally surprised to find it in those of large stature. It is generally said to occur but rarely in Germany and France, although it was observed in 37 and 28 per cent of the contracted pelves studied by Müller and Gönner respectively; and Richelet states that it is much more common in France than is generally believed. My own observations show that in Baltimore it constitutes the most usual type of abnormal pelvis occurring in both white and black women, as in a series of 11,630 consecutive deliveries its incidence was 5.38 and 20.63 per cent, respectively, in the two races. Or, to express it in another way, the generally contracted or justo-minor type makes up approximately 40 and 45 per cent of all contracted pelves occurring in white and black women, respectively. It is undoubtedly a sign of degeneration, and particularly in the colored race is a manifestation of the imperfect physical development incident to living in large cities. Müller considered that its frequency in Berne was probably due to the prevalence of cretinism in that locality, but the fact that Gönner observed it almost as frequently in Basel, where the latter disease occurs but rarely, militates against such a view. Especially in Negroes, it is quite possible that not a few so-called justo-minor pelves are really of rachitic origin, but lack the more striking changes characteristic of that disease.

The *diagnosis* is readily made. The existence of a generally contracted pelvis should always be suspected in small women, and especially in poorly developed asthenic women, although it should not be forgotten that it may occur in large and apparently well-formed individuals. Accurate information can be obtained by means of pelvimetry. All of the external measurements are considerably and uniformly shortened. Internal examination shows a shortened conjugata vera, with general smallness of the pelvic cavity, typical rachitic changes being absent. The average measurements in 36 white women in my clinic presenting pelves of this character were: spines, 23.25; crests, 25.7; trochanters, 26.3; Baudelocque, 17.9; and diagonal conjugate, 11.1 centimeters, while in 167 colored women each measurement was a few millimeters shorter.

It is usually taught that a generally contracted pelvis with a conjugata vera of a given length offers a greater obstacle to labor than a flat pelvis offering a similar measurement, and for practical purposes half a centimeter is usually added to the latter to reduce it to terms of the former. In my experience, however, this has not been the case, as the generally poor development, which characterizes the bearer of such a pelvis, tends to be transmitted to the child, so that the smaller size of its head frequently compensates for the less favorable mechanical conditions of the pelvis.

The Masculine Pelvis.—Michaelis directed attention to the fact that generally contracted pelves are occasionally encountered in which the bones are thicker and clumsier than usual and approach the male type. Pelves of this class occur much less frequently than is generally believed, as many which are so described are in reality typical funnel pelves. They have the same effect upon labor as the ordinary justo-minor variety, though in many instances the relatively greater contraction of the inferior strait may add to the dystocia.

Berry Hart, in 1916, pointed out that the pelvis may occasionally present an "inversion" of male and female characteristics, so that either its iliosacral or ischiopubic portion may conform to the male type, while the rest retains its typical feminine conformation. The former leads to abnormalities of the superior strait, while in the latter the ischiopubic rami become so approximated that a funnel pelvis results.

The Infantile Pelvis.—In rare instances, as the result of disease, which has caused the individual to spend her entire life in bed without attempting to sit up or walk, the pelvis retains the characteristic infantile form to which reference was made in Chapter I. Examples of this abnormality have been described by Naegele, Leisinger, Bittner, and Gurlt, but naturally it possesses no obstetrical significance.

The Dwarf Pelvis.—According to Breus and Kolisko, several varieties of dwarfs must be distinguished, *i.e.,* the "true," the hypoplastic, the chondrodystrophic, the cretin, and the rachitic dwarf. Guggisberg, on the other hand, distinguishes between proportionate and unproportionate dwarfism or nanosomia, and gives the following classification, in which A corresponds to the "true" and B2 to the hypoplastic dwarf:

Proportionate

A. Nanosomia primordialis
B. Nanosomia infantilis
  1. Nanosomia pituitaria
  2. Nanosomia hypoplastica
C. Nanosomia cerebralis

Unproportionate

(*a*) Rachitic dwarf
(*b*) Chondrodystrophic dwarf
(*c*) Hypothyroid dwarf
(*d*) Dwarfs due to congenital bone defects

The terminology is clear except in the case of the "true"and hypoplastic dwarf, since, as will become evident below, the type of person which one would usually associate with the former, is technically designated as the latter.

In the "true" dwarf there is a proportionate lack of general development, which is particularly characterized by the fact that the various epiphyses do not undergo ossification, but remain cartilaginous, until an advanced age.

In the *hypoplastic dwarf* the changes are quantitive instead of qualitative, so that the individual differs from the normal only in her miniature appearance.

In the chondrodystrophic dwarf the deformity results from chondrodystrophia fœtalis (Kaufmann), achondroplasia (Parrot and Porak), or fœtal rachitis, as the disease has been variously designated. The affection is not allied to rachitis, but is an entirely independent disease which begins *in utero,* and whose etiology is as yet unknown; although many recent writers are inclined to attribute it to abnormalities in the function of the endocrine glands, Wagner believing that it is associated with hyperfunction of the ovaries. It is characterized by changes in the epiphyseal cartilages, which interfere with the normal apposition of bone, with the result that the shafts of the long bones are imperfectly developed so that the individual presents a normally formed body, while the extremities are short and stumpy. In many instances the head is brachycephalic, with a prominent forehead and saddle nose. The musculature is often excessively developed, so that chondrodystrophic dwarfs may be unusually strong. Full details concerning the condition may be found in Rischbieth and Barrington's monograph on dwarfism. It is sometimes hereditary, and in such cases the tendency is usually transmitted through the father. Persons presenting the abnormality are frequently exceptionally fertile, and thus contrast markedly with cretin dwarfs, in whom sterility is the rule.

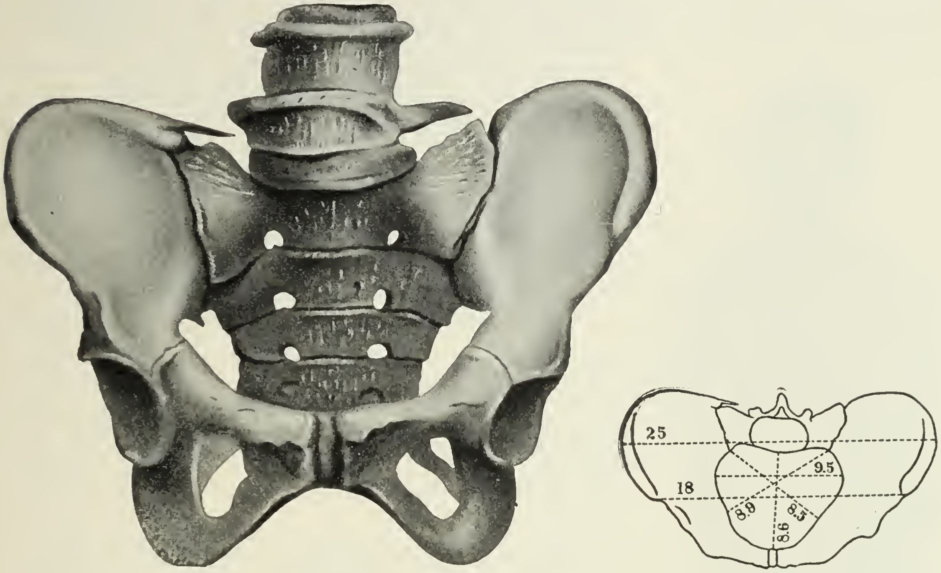

Fig. 617. Fig. 618.

FIGS. 617, 618.—TRUE DWARF PELVIS (Boeckh).

In the *cretin dwarf* the lack of development is general. The bony changes are allied to those observed in the true dwarf, but are less marked.

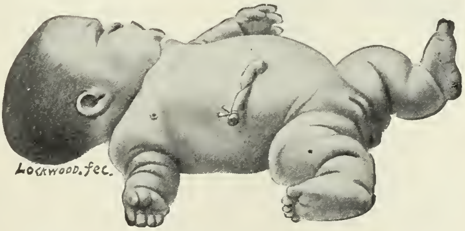

FIG. 619.—CHONDRODYSTROPHIA FŒTALIS.

The term *rachitic dwarf* should not be applied to individuals whose short stature is due to skeletal deformities, but should be restricted to those who would fall far below the normal height even if one imagined the deformities straightened out.

Each of these varieties of dwarfs has a characteristically shaped pelvis, which is more or less generally contracted.

The True Dwarf Pelvis (*Pelvis Nana*).—This variety of pelvis is extremely rare, only 4 well-marked specimens being in existence—those described by Naegele and Boeckh, Schauta, Paltauf, and Breus and Kolisko, two of which were in females. The pelvis is generally contracted and tends toward the infantile type, but its most characteristic feature is the persistence of cartilage at all the epiphyses. Thus, in Boeckh's pelvis, which belonged to a thirty-one-year-old woman, 108 centimeters tall, the Y-shaped cartilage at the acetabulum was clearly marked and the sacral vertebræ were not fused together (Fig. 617).

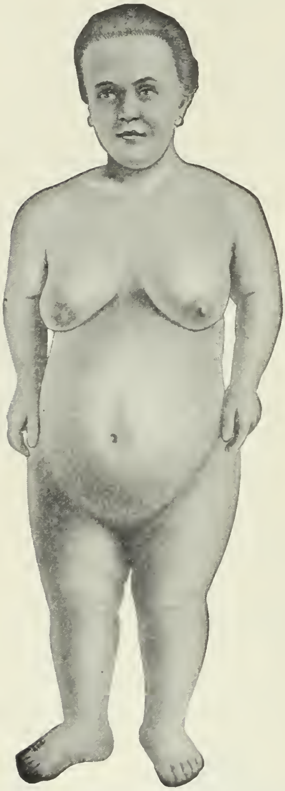

Fig. 620. — Chondrodystrophic Dwarf (Breus and Kolisko).

The Hypoplastic Dwarf Pelvis.—According to Breus and Kolisko this variety of pelvis is observed in very small individuals, and is simply a normal pelvis in miniature. It differs materially from that of the true dwarf in that it is completely ossified.

The Chondrodystrophic Dwarf Pelvis.—Figure 619 represents a chondrodystrophic infant, and Figure 620 a chondrodystrophic dwarf, whose pelvis, described by Breus and Kolisko, is reproduced in Figure 621. The woman was twenty-seven years old and 123 centimeters tall, and died after a cesarean section.

This variety of pelvis is characterized by an extreme anteroposterior flattening, so that on first glance one might believe that one had to deal with a rachitic pelvis. On closer examination, however, it is seen that the flattening is due to the imperfect development of the portion of the iliac bone entering into the formation of the iliopectineal line, owing to which the sacral articulation is brought much nearer the pubic bone than usual. In 6 pelves of this character described by Breus and Kolisko the conjugata vera varied from 4 to 7 centimeters, while the transverse diameter of the superior strait was but slightly shortened, varying from 11 to 12 centimeters.

The Cretin Dwarf Pelvis.—This is a generally contracted pelvis with poorly developed and imperfectly formed bones. Unlike that of the true dwarf, it does not present infantile characteristics, but shows signs of a steady though imperfect growth throughout early life. Unossified cartilage may be present here and there in young subjects, but it disappears with advancing age and is never found in all the epiphyses as in the true dwarf pelvis.

The Rachitic Dwarf Pelvis.—True rachitic dwarfs are rare, and possess generally contracted rachitic pelves, which do not differ from those described in the previous chapter except by their small size.

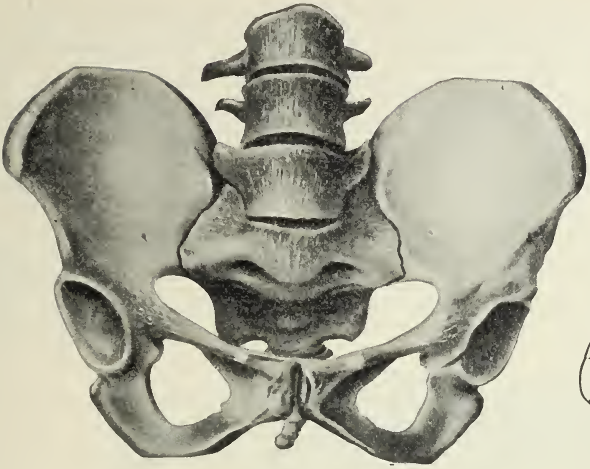

Fig. 621.

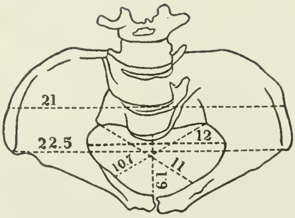

Fig. 622.

Figs. 621, 622.—Chondrodystrophic Pelvis (Breus and Kolisko).

II. LOCALIZED AND ASYMMETRICAL ANOMALIES IN DEVELOPMENT

The Obliquely Contracted or Naegele Pelvis.—Naegele, in 1803, was the first to recognize the significance of this variety of pelvis, and in 1839 published a monograph upon the subject based upon the study of 35 specimens, one of which had been obtained from an Egyptian mummy. Thomas, in 1861, was able to collect from the literature a description of 50 such pelves. Since then, additional specimens have been described, but it is unlikely that the entire number exceeds 100. As a matter of curiosity, it might be added that Bluntschli has recorded a specimen observed in a monkey.

The Naegele pelvis presents the following characteristics: The sacral ala on one side is normal, while the other is either lacking or imperfectly developed, and the corresponding sacral foramina are smaller. In the great majority of cases the sacrum and the innominate bone are firmly synostosed on the affected side. At the same time the latter is pushed upward and backward, as well as inward from the region of the acetabulum, so that its crest is at a higher level than that of its fellow. The iliopectineal line is almost straight when the deformity is marked, while upon the opposite side the curvature is accentuated, particularly in the anterior portion. Corresponding with the change in position of the innominate bone on the affected side, the ischial tuberosity and spine are displaced inward, upward, and backward, thereby approaching the outer margin of the sacrum and narrowing the sacrosciatic notch. The symphysis pubis is displaced toward the well side, while the pubic arch instead of looking directly forward is directed toward the abnormal side of the sacrum. The sacrum itself is displaced toward the ankylosed side, while its anterior surface is directed more or less obliquely toward it.

As a result of these changes the pelvis becomes obliquely contracted, the superior strait being ovate in shape, with its small pole directed toward the abnormal sacro-iliac joint and its large end toward the horizontal ramus of the pubis on the well side. Consequently, its oblique diameters are of unequal length, the shorter extending from the sacro-iliac synchondrosis of the well side to the iliopectineal eminence on the diseased side, while the conjugata vera is usually somewhat lengthened and is directed obliquely.

The walls of the pelvis converge below, so that the contraction involves the entire pelvic cavity, but is relatively greater in the plane of least pelvic dimensions, and in the inferior strait than at the superior strait. The acetabulum on the diseased side is directed more anteriorly, while that on the well side looks almost directly outward.

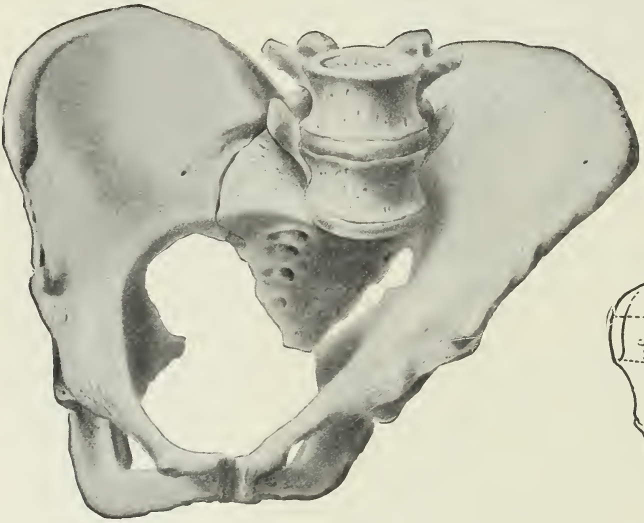

Fig. 623.

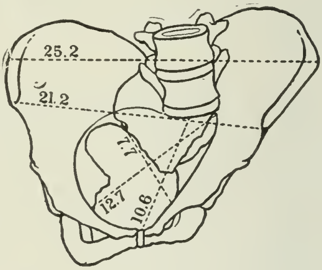

Fig. 624.

Figs. 623, 624.—Anterior View of Obliquely Contracted Pelvis (Naegele).

The distances from the promontory of the sacrum to the acetabulum and from the tip of the sacrum to the ischial spine are markedly diminished on the diseased side. At the same time the distance between the tuber ischii of the diseased side and the opposite posterior superior spine is less than that between the tuber ischii of the well and the corresponding spine of the diseased side. Moreover, the tip of the spinous process of the last lumbar vertebra is nearer the anterior superior spine of the ilium on the diseased than on the well side, while the distance from the lower margin of the symphysis to the posterior superior spine is less upon the well side.

Mode of Production.—The genesis of this variety of pelvic deformity has given rise to a great deal of discussion, some writers claiming that the defect in the sacrum is primary and the synostosis secondary; others, that the synostosis results primarily from inflammatory changes which bring about more or less destruction of the sacral ala. The former view was advocated particularly by Unna, Hohl, Litzmann, Olshausen, and Schauta, and the latter by Betschler, E. Martin, Thomas, and especially by Breus and Kolisko.

Following the advocacy of the last-mentioned authorities, the present tendency is to regard the abnormality as the result of inflammatory processes about the sacro-iliac joint, and to consider the synostosis as entirely secondary. Indeed, they deny that it ever arises from a primary defect in the development of the sacral ala, and therefore contend that such pelves should be designated as osteitic-synostotic.

My impression is that Breus and Kolisko have gone too far; more particularly as there was nothing in the history or examination of my patient presenting a Naegele pelvis to suggest that she had ever suffered from inflammatory bone disease. Furthermore, Hohl and others have shown that the entire sacral ala may be lacking without a sign of synostosis. In general, it may be said that the congenital origin of the condition is tenable only when all signs of a previous osteitic process are lacking.

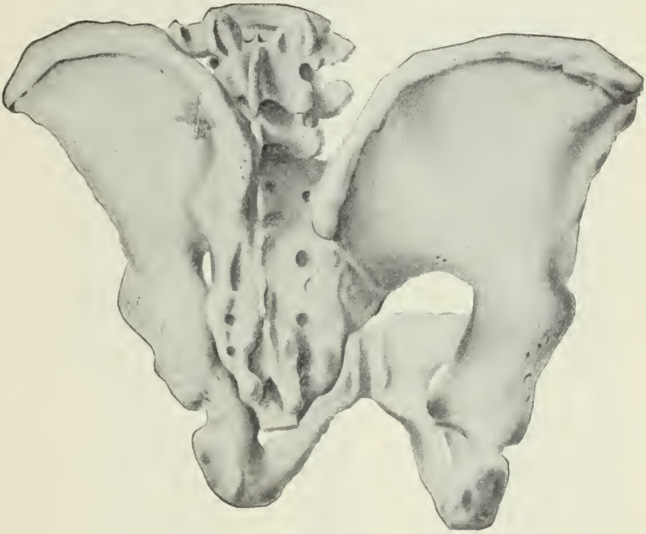

Fig. 625.—Posterior View of Obliquely Contracted Pelvis (Naegele).

The mechanism by which the deformity is produced is as follows: Owing to the asymmetry of the sacrum there is compensatory scoliosis of the lumbar portion of the vertebral column with its convexity on the diseased side. This causes the pelvis to assume an angle with the horizon, thereby bringing about a lowering of the acetabulum on the diseased side. As a consequence greater pressure is exerted by the femur on that side, which gradually brings about an upward, backward, and inward displacement of the corresponding innominate bone. Owing to the increased pressure, the synovial membrane at the sacro-iliac synchondrosis gradually undergoes pressure necrosis, and synostosis eventually results.

Diagnosis.—Generally speaking, the condition is readily recognizable, provided that one's attention is directed to its possible existence. Unfortunately, such patients rarely limp, show no great external deformity and, as a rule, give no history suggestive of trouble at the sacro-iliac joint (Fig. 626). Consequently, since the customary external measurements give no clue to its presence, the diagnosis of a justo-minor pelvis is usually made, unless the asymmetry of the outlet or the actual occurrence of dystocia leads one to make a more complete examination. On the other hand, the existence of scoliosis, a variation in the height of the hips, or a difference in the distance between the spine of the last lumbar vertebra and the posterior superior spine on either side should cause one to suspect its possibility, when a radiogram will settle the question, as in the case described by me in 1929.

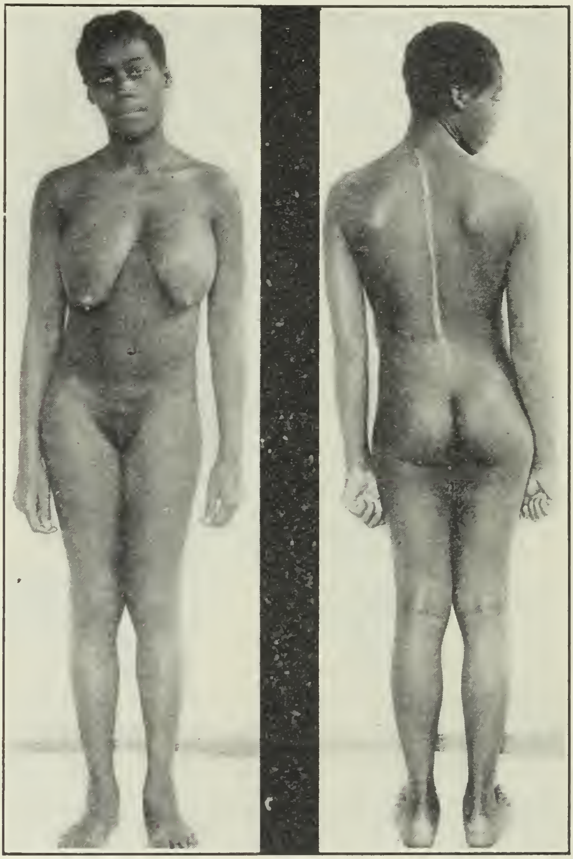

FIG. 626.—PATIENT WITH NAEGELE PELVIS.
Note comparatively slight external deformity.

Naegele suggested five measurements which should be made in such cases: (1) from the tuber ischii of one side to the opposite posterior superior spine;

(2) from the anterior superior spine of one side to the opposite posterior superior spine; (3) from the spine of the last lumbar vertebra to the anterior superior spine on either side; (4) from the trochanter to the opposite posterior superior spine; (5) from the lower margin of the symphysis pubis to the posterior superior spines on either side. Normally, these various measurements should be the same on both sides, but they differ considerably in obliquely contracted pelves.

Owing to the difficulty of definitely locating their end points, the first, fourth, and fifth measurements are rarely employed; but the information obtained from the second and third is of very considerable value. A difference of more than 1 centimeter between these measurements on the two sides indicates an obliquely contracted pelvis, but is not sufficient to enable one to differentiate between the Naegele and the other varieties. On internal examination the conjugata vera is not shortened, but on measuring the diagonal conjugate it is found that the symphysis pubis, instead of being situated directly in front of the promontory, lies considerably to one side of it. On palpation it is found that the sacrum is asymmetrical, and that the lateral wall of the pelvis, as well as the ischial spine and tuberosity, approaches it much more closely on the diseased than on the opposite side, while the iliopectineal line is markedly flattened. At the same time the distance between the tubera ischii is greatly diminished.

Effect upon Labor.—When the deformity is pronounced, the side of the pelvis corresponding to the small end of the oval is so contracted as to be useless for the passage of the child, so that engagement, if it is to occur at all, must take place on the opposite side. In effect, the pelvic inlet becomes converted into one of the generally contracted type, and an idea of its available space is gained by measuring, not the conjugata vera, but the distance between the symphysis pubis and the sacro-iliac synchondrosis on the normal side. Owing to the contraction in the lower portion of the pelvis, still further difficulty is experienced when the head attempts to pass between the ischial spines and tuberosities, and the possibility of delivery also depends upon the distance between these points.

Prognosis.—If the deformity is pronounced the prognosis is bad, unless cesarean section be performed. Litzmann stated that in preantiseptic days 22 out of 28 mothers died in the first labor, and that only 6 labors ended spontaneously out of the 41 making up his entire series. The fact that the patient has previously had spontaneous labor does not necessarily imply that she will do likewise in the future. Thus, my patient had given birth to six small children spontaneously, only to perish from rupture of the uterus at a seventh labor, when the child was 500 grams heavier.

Generally speaking, spontaneous labor is out of the question unless the short oblique diameter measures at least 8.5 centimeters (8.4 centimeters in my case), and even here the prognosis will depend upon the size of the child. Below this limit cesarean section is the only rational method of treatment provided the child is alive and the patient in good condition. Pinard in one instance gained sufficient room for the delivery of the child by sawing through the horizontal ramus of the pubis and the ascending ramus of the ischium on the diseased side—ischiopubiotomy. The operation was strongly condemned by Budin, and its performance is not to be recommended, for the reason that the sacro-iliac ankylosis may prevent sufficient expansion of the pelvis.

III. LOCALIZED AND SYMMETRICAL ANOMALIES IN DEVELOPMENT

These may be of several characters: (*a*) Imperfect development of both sacral alæ; (*b*) lack of union at the symphysis pubis; (*c*) lack of development of the vertebral bodies of the sacrum; (*d*) assimilation of the last lumbar vertebra with the sacrum, or of the first sacral vertebra with the lumbar column.

The Transversely Contracted or Robert Pelvis.—Imperfect development of both sacral alæ produces a pelvis which is markedly contracted transversely, and is sometimes described as the *double Naegele pelvis.* This variety is extremely rare, Tarnier stating that only 10 cases had been described up to 1898 (Fig. 627).

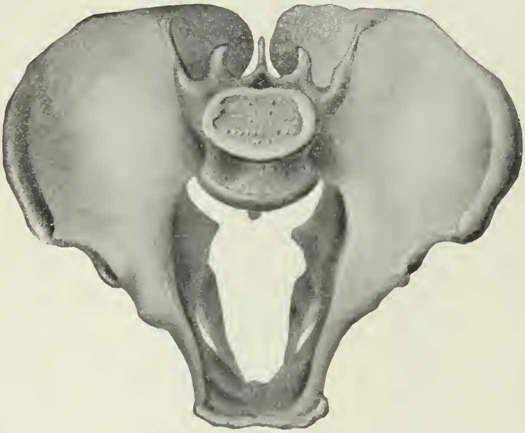

Fig. 627.

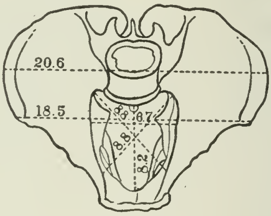

Fig. 628.

FIGS. 627, 628.—TRANSVERSELY CONTRACTED PELVIS (Robert).

In the pelvis described by Robert, both alæ of the sacrum were lacking, and the innominate bones were firmly synostosed with the rudimentary sacrum. The anterior surface of the latter was convex in both directions. Owing to the imperfect development of the sacrum, the pelvis was markedly contracted transversely, and only slightly anteroposteriorly, the transverse and anteroposterior diameters of the superior and inferior straits measuring 7 and 9.7, and 5.1 and 10.6 centimeters, respectively.

Just as in the Naegele pelvis, two views are held as to its etiology; some considering it to lie in a primary defect in the development of the sacral alæ, while others, particularly Breus and Kolisko, hold that it is always the result of inflammatory processes. Indeed, bony unison between the sacrum and innominate bones is not an essential characteristic, and is occasionally lacking, sometimes on one, much more rarely on both sides. Where there is a difference in the development of the alæ on the two sides it can readily be understood how an asymmetrically transversely contracted pelvis may result.

The diagnosis is readily made, all of the transverse external measurements being markedly shortened, while the external conjugate remains practically normal. Internal examination shows the conjugata vera to be only slightly changed, while it is hardly possible for the close approach of the ischial spines and tuberosities to one another to escape recognition. In all cases thus far reported the transverse narrowing of the pelvis was so great as to preclude the possibility of the birth of a living child, and accordingly cesarean section is the only rational method of treatment.

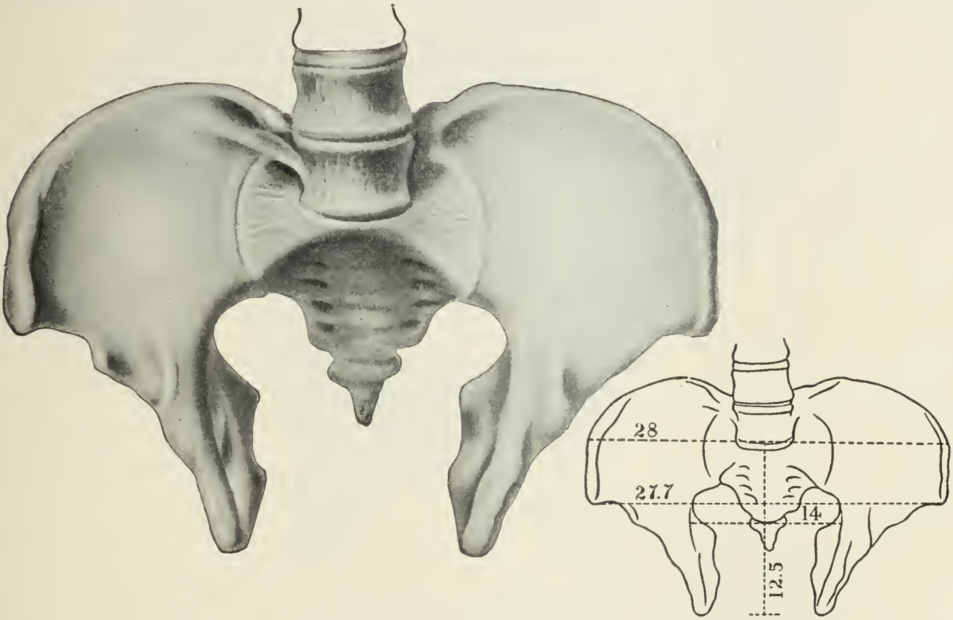

Fig. 629. Fig. 630.

Figs. 629, 630.—Split Pelvis (Breus and Kolisko).

Split Pelvis.—In rare instances union between the pubic bones at the symphysis does not occur, and the anterior portions of the pelvis gape widely (Fig. 629). This condition is usually associated with ectopia of the bladder and imperfect development of the lower portion of the anterior abdominal wall. As such abnormalities greatly diminish the probability of prolonged life, the condition is more common in young children than in adults. We are indebted to Litzmann for the first accurate description of a pelvis of this character from an obstetrical point of view.

In the split pelvis, owing to descent of the promontory of the sacrum and the absence of union at the symphysis, there is marked transverse widening of the posterior portion of the pelvis, while its anterior portions extend more or less parallel. External pelvimetry in such cases shows a pronounced flaring of the anterior superior spines of the ilium, and were the defective condition of the symphysis pubis not clearly evident a rachitic pelvis might be suspected.

The distance between the extremities of the pubic bones varies considerably, and occasionally is as great as 14 centimeters. This space is usually filled by a fibrinous band. Schickele, in 1901, reported a case of labor in a pelvis of this character, and stated that 8 others were to be found in the literature. In only 2 of them was labor spontaneous, but in none was great difficulty experienced; consequently for practical purposes the pelvis may be considered as generally enlarged, the dystocia being due to abnormalities of mechanism resulting from the absence of a resistant anterior pelvic wall. Gemmel and Paterson, in 1913, described a remarkable case, in which the entire generative tract, as well as the bladder, was doubled. In this patient successive pregnancies occurred in either uterus and all eventuated in spontaneous labor. Breus and Kolisko give an excellent description of several hitherto undescribed cases, and discuss fully the mechanical factors concerned in their production; while Miller has carefully reviewed the literature upon the subject up to 1918.

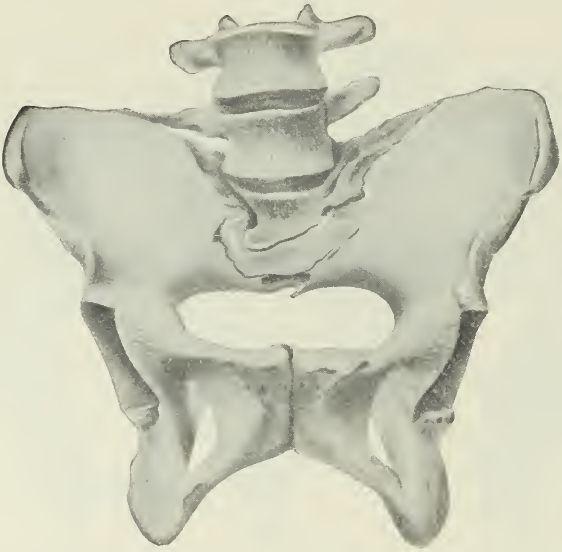

Fig. 631.—Contracted Pelvis Due to Absence of Bodies of Sacral Vertebræ (Litzmann).

Imperfect Development of the Vertebral Bodies of the Sacrum.—Litzmann has described a remarkable pelvis, in which almost the entire sacrum was lacking. This defect was associated with considerable transverse contraction, which increased as the inferior strait was being approached, the transverse diameter of the superior strait measuring 10.5 centimeters, while the distance between the ischial spines and ischial tuberosities was 6.5 and 8.5 centimeters, respectively (Fig. 631).

Assimilation Pelvis.—Quite frequently the transverse processes of the last lumbar vertebra may be transformed into structures similar to the lateral masses of the sacral vertebræ, and fuse with them. In this event the former assumes the functions of the first sacral vertebra, the sacrum being now composed of 6 instead of 5 pieces. In other instances the first sacral vertebra may take on the characteristics of a lumbar vertebra and become assimilated to the lumbar column, so that there are 6 lumbar and only 4 sacral vertebræ. Occasionally the first coccygeal vertebra may become assimilated with the sacrum, but this has no effect upon the character of the pelvis.

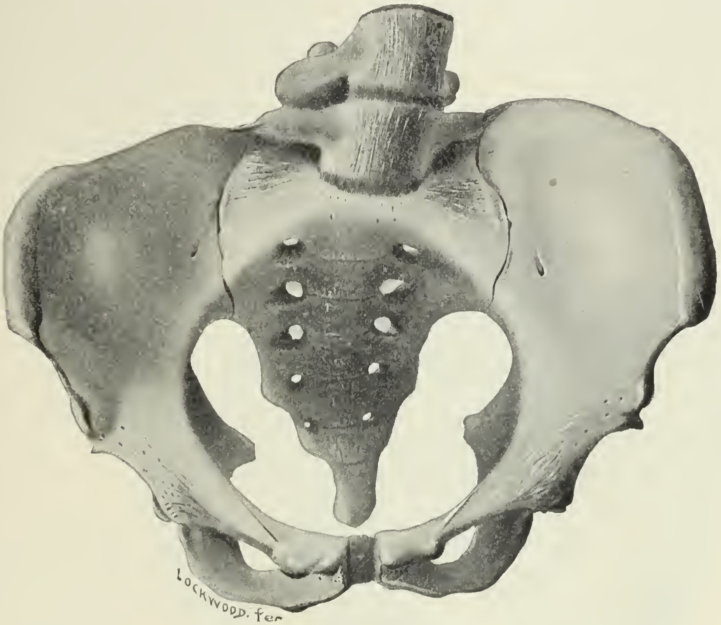

Fig. 632.

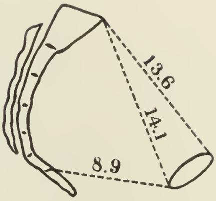

Fig. 633.

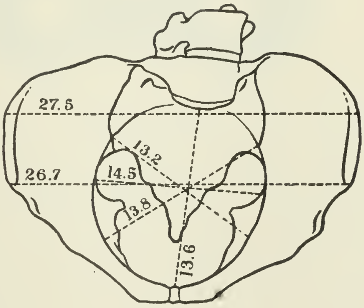

Fig. 634.

Figs. 632-634.—High Assimilation Pelvis.

Unless the entire vertebral column is available for study, it is frequently difficult to determine with which variety of assimilation one has to deal, as it is impossible to ascertain whether what corresponds to the first sacral vertebra is the twenty-fifth vertebra, as normal, or is the twenty-fourth or twenty-sixth vertebra, as the case may be. According to Rosenberg, in the development of the pelvis the first portion of the sacrum to enter into the formation of the sacro-iliac joint is the twenty-sixth vertebra, which normally corresponds to the second sacral, the twenty-fifth vertebra not becoming involved until later. Accordingly, a sacrum with only four vertebræ may indicate the persistence of a fœtal type, while the presence of six vertebræ shows that the normal process of articulation has been exaggerated.

Assimilation is the most common of all pelvic abnormalities, and is noted in at least every fifth or sixth pelvis; indeed Paterson noted it in 38 per cent of all dried pelves which he studied. In a series of 217 Indian squaw pelves, Emmons found that its incidence was 21.7 per cent. Unless especially sought for, the condition is usually overlooked, so that it frequently happens that pelves which have been demonstrated for years by trained anatomists as typically normal present one or other type of this abnormality. Moreover, the condition may be associated with rachitis or general imperfect development, in which event one has to deal with rachitic or generally contracted assimilation pelves (Fig. 601). More commonly, however, such an association is lacking, but the mere existence of assimilation may, nevertheless, give rise to marked changes in the shape of the pelvis.

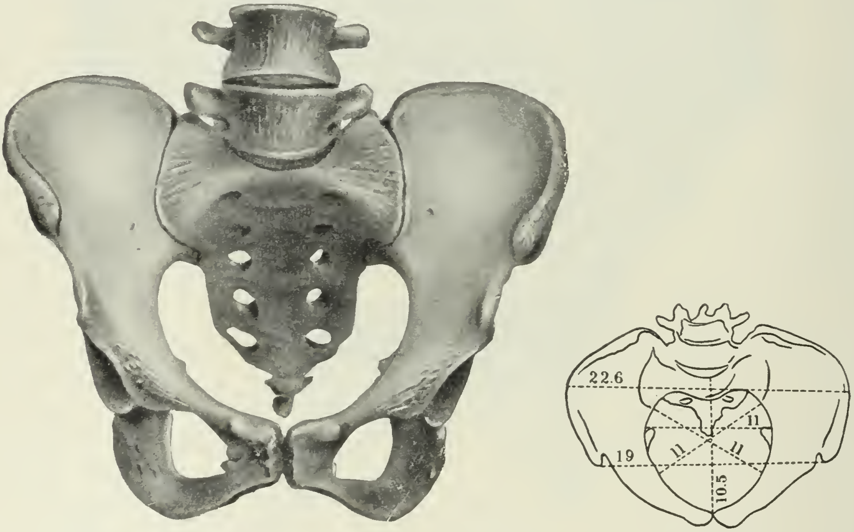

Fig. 635. Fig. 636.

Figs. 635, 636.—Transversely Contracted Assimilation Pelvis (Breus and Kolisko).

When the last lumbar is assimilated with the first sacral vertebra—high assimilation—so that the sacrum consists of 6 pieces, important changes in the shape of the pelvis result, which depend in great part upon the manner in which the sacrum and innominate bones articulate, as well as upon the width of the former. In some cases the condition gives rise to a pelvis which is very high in its posterior portion, and whose superior strait is almost round, the walls of its inferior portion converging, thus producing a funnel-shaped pelvis (see Fig. 632). In other cases the condition gives rise to a pelvis with a somewhat transversely contracted superior strait (see Fig. 635), in which the conjugata vera is either relatively or absolutely longer than the transverse diameter. Fabre and Bourret have carefully studied this type of pelvis from a clinical point of view, and state that it favors engagement of the head with the sagittal suture directly anteroposteriorly, instead of obliquely as usual; so that it should be regarded as an essential factor in the production of primary anterior or posterior occipital presentations.

On the other hand, when the first sacral vertebra is assimilated with the lumbar column—low assimilation—a pelvis results which is very shallow in its posterior portion, but which offers no particular obstacle to labor (see Fig. 637).

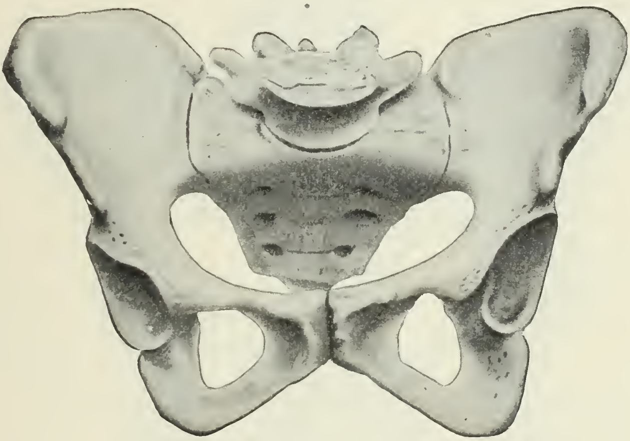

Fig. 637.—Low Assimilation Pelvis (Breus and Kolisko).

Occasionally the assimilated vertebra may undergo only a partial change, one side of it retaining the characteristics of a lumbar or sacral vertebra, as the case may be, while the other side undergoes considerable modification. Under such circumstances asymmetrical pelves result, which are frequently obliquely contracted and sometimes associated with scoliosis (see Fig. 638).

Funnel Pelvis.—Until recently, it was believed that the most characteristic examples of funnel-shaped pelvis are associated with lumbo-sacral kyphosis; and while contractions of the pelvic outlet are also noted in spondylolisthetic, osteomalacic, obliquely contracted, and other rare types of abnormal pelves. They occur so rarely that they are of scientific rather than practical importance.

On the other hand, moderate degrees of outlet contraction are frequently noted under other conditions. Thus, in every fourth or fifth justo-minor pelvis the measurements of the inferior strait are diminished out of proportion to the rest of the pelvis, and occasionally to such an extent as to give rise to outlet dystocia. In such cases the diagnosis of general contraction should inevitably direct one's attention to the possible existence of the abnormality, so that it is not likely to pass unnoticed.

Unfortunately, more or less serious contraction of the outlet frequently occurs in pelves which appear to be perfectly normal, so far as the usual external pelvic measurements are concerned. Such pelves I have designated as typical funnel, in contradistinction to the generally contracted variety to which reference has just been made. If outlet pelvimetry is not made an integral part of the preliminary obstetrical examination, the former usually passes unnoticed unless the contraction is so marked as to give rise to serious dystocia. In which event the physician may find himself in the embarrassing position of being obliged to resort to a radical operation in order to save the child, after having assured the patient that her pelvis was perfectly normal.

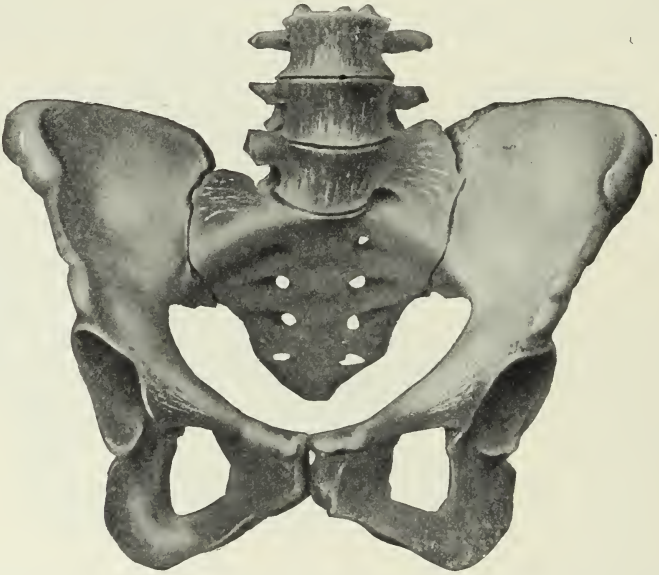

FIG. 638.—ASYMMETRICAL ASSIMILATION PELVIS (Breus and Kolisko).

Whenever the transverse diameter of the outlet measures 8 centimeters or less I designate the pelvis as funnel, and typical funnel pelves were noted in 6 per cent of a series of 10,000 consecutive patients whom I had examined up to October, 1924. In this series it was the second most frequent abnormality observed in white women, making up one-third of the contracted pelves occurring in that race. On the other hand, it constituted only one eighth of the abnormal pelves in black women. Notwithstanding this marked difference in the relative ratio, its actual incidence in the two races was practically identical—5.06 and 6.44 per cent, respectively.

Thoms made similar observations in my service, in 1915, when he reported an incidence of 4.96 and 5.76 per cent in white and colored women, respectively. Indeed, since my first communication upon the subject, all who have made similar investigations agree that the typical funnel pelvis constitutes one of the most important pelvic abnormalities encountered in American white women. Furthermore, the fact that Emmons observed the abnormality in 9.2 per cent of 217 Indian squaw pelves indicates that its occurrence is much more widespread than was formerly believed.

The fact that the incidence of the typical funnel pelvis is practically the same in black and white women is of great importance in determining its mode of production; for, when it is remembered that in my material the usual types of contracted pelvis occur four times more frequently in the former than in the latter, it becomes evident that outlet contractions must be due to some factor other than rachitis or imperfect general development, which plays so conspicuous a part in the genesis of abnormal pelves in the colored race. Formerly it was believed that the condition was a manifestation of the existence of a masculine or an infantile type of pelvis, but my observations have taught me that such is not the case, and I now believe that many outlet contractions, at least, are associated with high assimilation, namely, the presence of six vertebræ in the sacrum. This may so alter the relations at the sacro-iliac joints that the walls of the lower portion of the pelvic cavity converge, while the superior strait retains approximately its normal proportions.

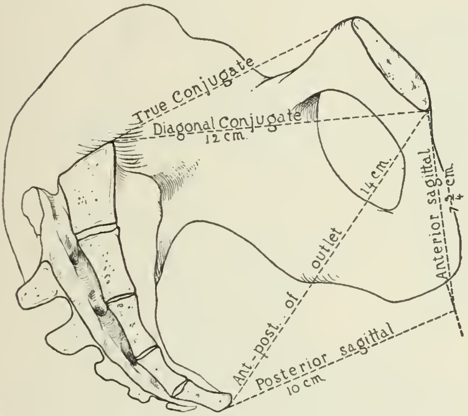

Fig. 639.—Diagram Showing the Significance of Anterior and Posterior Sagittal Diameters. × ⅓.

Spontaneous labor through a transverse diameter of 5.5 cm.

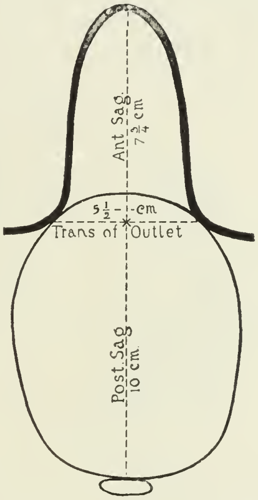

Fig. 640.—Diagram of Pelvic Outlet of Same Case, Illustrating Possibility of Spontaneous Labor Owing to Long Posterior Sagittal Diameter. × ⅓.

The correctness of such a view is demonstrated by the fact that I was able to palpate six sacral vertebræ in a number of my patients, and in many more to detect the existence of a false or second promontory. That definite proof could not be adduced in all cases is not surprising, as it is extremely difficult to count the sacral vertebræ accurately on vaginal or rectal palpation. Nevertheless, I feel that the demonstration of the existence of high assimilation in a small number of living women justifies the assumption that it really occurs much more frequently.

Earlier in this chapter attention was directed to Berry Hart's views on sexual inversion in the pelvis, when it was stated that he held that the existence of male characteristics in the ischiopubic portion, in association with female characteristics in the iliosacral portion, would give rise to a funnel pelvis. I am not prepared to express an opinion upon this point, and it must be left to future research to determine the correctness of such views.

In the great majority of funnel pelves the shortening is limited to the transverse diameter of the pelvic outlet. Ordinarily this is reduced to between 7 and 8 centimeters, but occasionally it is less, and in one of my patients it measured only 5.5 centimeters (Figs. 639 and 640). Exceptionally, the decrease in the distance between the tubera ischii may be associated with a shortening of the anteroposterior diameter of the outlet, which greatly increases the gravity of the condition, as will be indicated below. In still rarer instances, the contraction may be limited to the anteroposterior diameter and this is usually associated with flattening at the superior strait; although, of course, the most typical examples occur in the kyphotic and spondylolisthetic pelvis. Contractions of the latter type, however, are not classified as typical funnel pelves, and will be considered in their appropriate place.

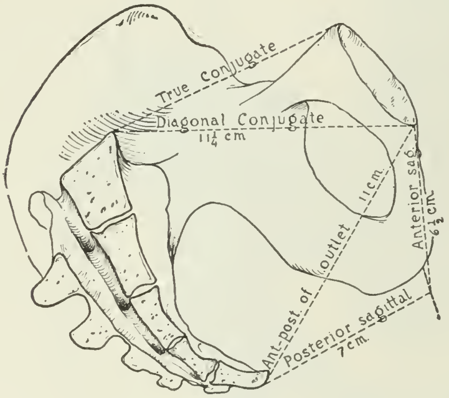

Fig. 641.—Diagram Showing the Significance of Anterior and Posterior Sagittal Diameters. × ⅓.
Cesarean section in spite of a transverse diameter of 6.5 cm.

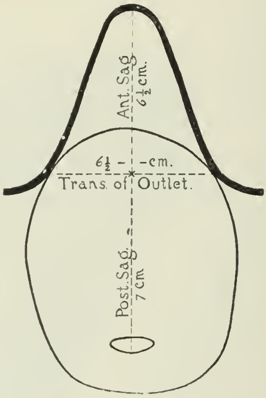

Fig. 642.—Diagram of Pelvic Outlet of Same Case, Illustrating Necessity for Cesarean Section. × ⅓.

That contractions of the pelvic outlet may seriously affect the course of labor is shown by the fact that in 135 labors complicated by it and included in my paper of 1911, the following operations were necessary to effect delivery: namely, 17 forceps, 1 cesarean section, 3 pubiotomies, and 1 craniotomy upon the after-coming head. Moreover, even when the disproportion is not sufficiently great to give rise to serious dystocia, it may play an important part in the production of perineal tears. In such cases, with the increasing narrowing of the pubic arch, the occiput cannot emerge directly beneath the symphysis pubis, and accordingly must stem itself further and further down upon the ischiopubic rami, and in extreme cases must rotate around a line joining the ischial tuberosities. Consequently the perineum must become more and more distended, and thus be exposed to great danger of extensive rupture. Schumacher believes that this type of pelvis has a serious effect upon the mechanism of labor by hindering the anterior rotation of obliquely posterior occipital presentation, and states that it was present in one-third of his cases of persistent deep transverse presentations.

In view of the frequency and practical significance of outlet contractions, palpation of the pubic arch, as described in Chapter XXXIII, should form an integral part of the preliminary examination of every pregnant woman. If any abnormality be detected the various diameters of the pelvic outlet should be carefully measured.

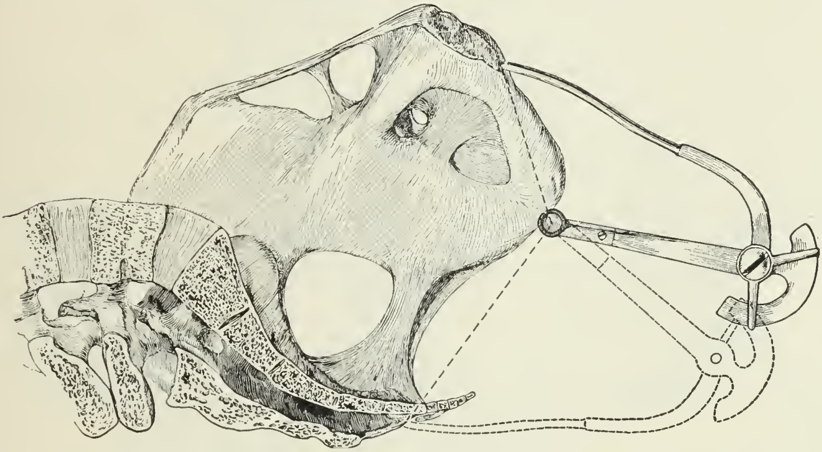

Fig. 643.—Diagram Illustrating Mensuration of the Anterior and Posterior Sagittal Diameters of Outlet by Means of Thoms' Pelvimeter. × ⅓.

A shortening of the transverse diameter to 8 centimeters or less should be regarded as a danger signal; but, unfortunately, as Klien, in 1896, pointed out, the length of this diameter, either alone or in combination with that of the anteroposterior diameter, does not afford a sufficient basis for the formulation of an intelligent prognosis. Thus, it may happen that serious dystocia may sometimes arise with a transverse diameter of 7.5 centimeters, while on the other hand spontaneous labor may occur when it is reduced to 5.5 centimeters, as in one of my cases (Figs. 640-642).

This apparent discrepancy is readily understood when it is remembered that a decrease in length of the transverse diameter is associated with a progressive narrowing of the pubic arch, so that only a smaller and smaller segment of the head can pass beneath it, and in extreme cases only the portion of the outlet posterior to a line joining the ischial tuberosities is available for its passage. In such an event, it is evident that the possibility of delivery will depend not upon the actual length of the transverse nor of the anteroposterior diameter, but rather upon the space available between the transverse diameter and the tip of the sacrum.

Klien has designated this distance as the posterior sagittal diameter of the outlet, and devised a specially constructed pelvimeter for its mensuration. For years I obtained satisfactory results by the use of a modification of Klien's instrument, which, however, had the disadvantage that two persons were required for its manipulation, so that its employment was practically restricted to hospital patients. Thoms, while working in my clinic, devised the instrument described in Chapter XXXIII, which can be manipulated by one person, and can be used for measuring the distance between the tubera ischii, as well as the anterior and posterior sagittal diameters of the outlet.

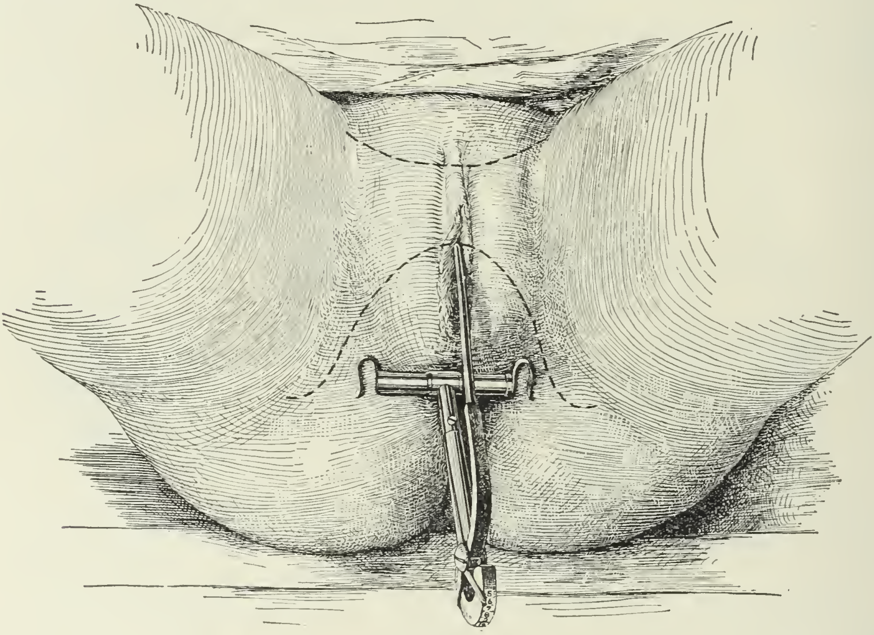

FIG. 644.—SHOWING MENSURATION OF ANTERIOR SAGITTAL DIAMETER OF OUTLET BY MEANS OF THOMS' PELVIMETER. × ⅓.

For the latter purpose, the transverse bar of the pelvimeter is held by the fingers of one hand in relation with the transverse diameter of the outlet, while the end of the free blade is brought in contact with the lower margin of the symphysis—this gives the length of the anterior sagittal diameter. The long arm of the pelvimeter is rotated, and the distance to the tip of the sacrum is determined—external posterior sagittal diameter (Figs. 643 and 644). The former varies between 5 and 6 centimeters and is subject to comparatively little change; while the external posterior sagittal may vary greatly, and from it the length of the posterior sagittal may be estimated by deducting 1 centimeter—the average thickness of the tip of the sacrum.

In order for spontaneous labor to occur it is apparent that this diameter must increase proportionally in length as the transverse diameter of the outlet is shortened, and my observations show that it is unlikely with measurements less than the following:

Transverse Diameter, Cm.	*Posterior Sagittal, Cm.*
8	7.5
7	8
6.5	8.5
6	9
5.5	10

It should, however, be understood that these are only approximate estimates and by no means accurately indicate the necessity for radical interference, as spontaneous labor may occur when least expected. The same may be said of Thoms' dictum that spontaneous birth of a normal sized child is unlikely unless the sum of the transverse and posterior sagittal diameters exceeds 15 centimeters. In general, it may be said that in multiparous women with a history of previous severe dystocia, such measurements may afford an indication for cesarean section or pubiotomy; while in primiparous women, if spontaneous labor does not occur, they should lead us to substitute pubiotomy for brutal attempts at forceps delivery.

In young women pubiotomy is the operation of choice whenever the dystocia is serious, as it not only permits delivery at the time, but also offers a reasonable prospect of permanently overcoming the abnormality. In my article upon the effect of pubiotomy upon the course of subsequent labor, I have given details of several such cases, and have shown that as the result of the operation the funnel pelvis had become converted into a normal one, or if this did not occur that the softening and stretching of the fibrous union at the pubiotomy wound made possible a temporary enlargement sufficient to permit spontaneous labor. On the other hand, in multiparous women who have already lost one or more children, cesarean section at an appointed time should be chosen, as by so doing the birth of a living

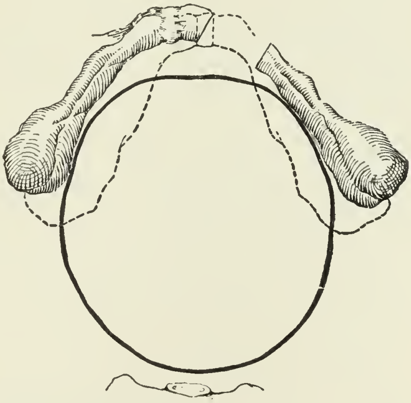

Fig. 645.—Diagram Illustrating Effect of Pubiotomy in a Pronounced Funnel Pelvis.

Dotted lines show pubic arch before operation. × ⅓.

child will be assured, while with pubiotomy the child will be exposed to a slight, but definite risk.

In moderate degrees of outlet contraction the effect of postural treatment should be tested before resorting to the use of forceps, as I have found that by placing the patient in an exaggerated Sims' position the innominate bones rotate upon the sacrum to such an extent that the length of the posterior sagittal undergoes an average increase of 0.75 centimeter, with extremes of 0 and 4 centimeters. In minor degrees of contraction, such an increase may be sufficient to do away with the necessity for the use of forceps.

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CHAPTER XXXVI

COURSE, PROGNOSIS AND TREATMENT OF PREGNANCY AND LABOR COMPLICATED BY THE MORE COMMON FORMS OF CONTRACTED PELVIS

Marked degrees of pelvic deformity exert a pronounced influence upon the course of pregnancy as well as upon the mechanism of labor. Indeed, to be unaccompanied by more or less definite effects the contraction must be minimal.

EFFECT OF CONTRACTED PELVIS UPON THE COURSE OF PREGNANCY

The Position of the Uterus.—Very exceptionally in the early months of pregnancy a pronounced degree of pelvic malformation may interfere with the normal rising up of the uterus, particularly if the promontory of the sacrum projects so far into the superior strait as markedly to overhang the pelvic cavity. In these rare cases as the uterus increases in size it may assume a position of pronounced retroflexion, which later may give rise to characteristic symptoms of incarceration.

Later in pregnancy, when the deformity is sufficient to interfere materially with the descent of the presenting part into the pelvis, marked abnormalities in the position of the uterus are observed. Particularly in primiparæ, the fundus occupies a higher position than usual, and serious respiratory and circulatory disturbances often result. At the same time, owing to the fact that the lower portion of the uterus is not fixed by the engaged head, the entire organ is more freely movable than usual.

More important, however, is the sharply anteflexed position which the uterus may assume. This is particularly the case in small women presenting marked lumbar lordosis, whereby the capacity of the abdomen is so diminished that the growing uterus seeks to gain room by pushing forward the anterior abdominal walls. Consequently, the presence of a *pendulous abdomen* is a sign of considerable importance in primiparous women, and should always cause one to suspect the existence of marked pelvic deformity. The converse, however, does not necessarily indicate that no disproportion exists. On the other hand, the same condition may have no great significance in multiparous women, being generally due to a loss of tonicity of the uterine and abdominal walls as a result of previous pregnancies.

Position and Presentation of the Fœtus.—A contracted pelvis plays an important part in the production of abnormal presentations. In normal primiparous women, the presenting part, as a rule, descends into the pelvic cavity during the last six weeks of pregnancy; but when the superior strait is considerably contracted this does not occur at all, or not until after the onset of labor. Vertex presentations still predominate; but since the head floats freely above the superior strait, or rests upon one of the iliac fossæ, very slight influences may cause the fœtus to assume other positions. According to Michaelis, vertex presentations are rarer by 10 per cent in contracted than in normal pelves; while face, breech, and transverse presentations occur two or three times, and prolapse of the cord and the extremities four to six times more frequently.

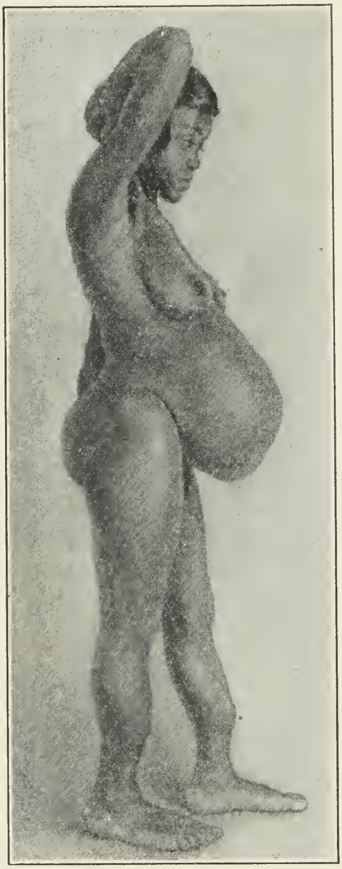


Fig. 646.—Pendulous Abdomen in a Primipara with a Generally Contracted Rachitic Pelvis.

That abnormal presentations increase in frequency with the degree of contraction is shown by the following figures of Michaelis, Litzmann, and Schwartz:

Conjugata Vera	*Vertex Presentations*
9.5—8.5 cm.	93.1 per cent
8.4—7.5 cm.	83.8 per cent
7.4 cm. or less	64.7 per cent

In 2274 labors complicated by contracted pelvis occurring in my service between 1910 and 1924, the following incidence for the various presentations was noted:

Vertex:	92 ,	instead of		96	per cent
Breech:	5.34,	"	"	3	" "
Face:	0.58,	"	"	0.4	" "
Transverse:	1.77,	"	"	0.5	" "
Compound:	0.27,	"	"	0.0	" "

In other words, breech presentations were noted twice and transverse presentations three times as frequently as under normal conditions.

Since abnormal presentations occur more frequently in multiparous than in primiparous women even under favorable conditions, they become still more common when the pelvis is contracted. Thus, Schauta estimated that they are three times more frequent in the fifth than in the first pregnancy.

In primiparous women face and transverse presentations possess a peculiar significance, as their occurrence is nearly always associated with serious disproportion between the size of the head and the pelvis, so that whenever either variety is encountered one can feel certain that the head is unusually large or the pelvis abnormally small.

Size of the Fœtus.—La Torre, Pinard, and others have stated that the children of women with abnormal pelves usually attain a larger size than usual. Wilcke, and Riggs, however, have concluded that such is not the case. In my experience, women with generally contracted pelves tend to have smaller children than usual, while with the simple flat and flat rachitic types the children tend to be large. This is probably due to the fact that in the former the contracted pelvis represents only one of the many stigmata of degeneration which characterize the patient; whereas in the latter no signs of general physical degeneration are present. Naturally, as more colored than white women present generally contracted pelves, more small children are noted among the former. The following table shows the conditions noted in 2732 cases studied in my service:

PERCENTAGE OF CHILDREN WEIGHING 3250 GRAMS OR MORE IN THE SEVERAL TYPES OF CONTRACTED PELVIS

TYPE OF PELVIS	WHITE			BLACK		
	No.	3250 Grams or More	Per Cent	No.	3250 Grams or More	Per Cent
Generally contracted	296	103	34.7	932	263	28.2
Simple flat	135	77	57.1	41	21	51.2
Generally contracted rachitic..	30	14	46.7	749	212	28.3
Flat rachitic	46	20	43.5	15	9	60.0
Funnel	230	115	50.0	259	90	34.7
TOTAL	737	329	44.64	1996	595	29.81

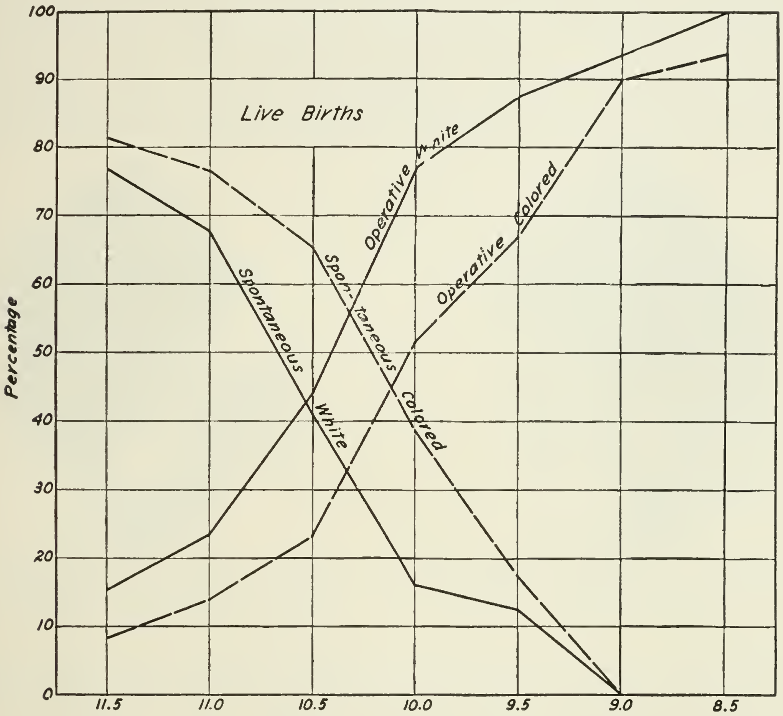
MECHANISM OF LABOR IN RACHITIC PELVES

The possibility of the occurrence of spontaneous labor in flat pelves depends primarily upon the degree of contraction, and, when this is not excessive, upon the following additional factors: the size, compressibility, and malleability of the fœtal head, and the character of the expulsive forces. The measurements of the pelvis can be determined with reasonable accuracy; with practice one can learn to estimate the size of the head with some degree of exactness, but there are no satisfactory methods of determining in advance the other properties of the head, and not until labor is well advanced can one predict even approximately what the uterus will do.

Taking all types of contracted pelvis together, spontaneous outcome may be expected to occur in approximately 80 per cent, but it becomes progressively less frequent with increasing pelvic deformity. Furthermore, as a result of the smaller size of the colored child more spontaneous and fewer operative deliveries occur in black than in white women. This is strikingly shown by the following graph, which is based upon 2242 live births, and in which the ordinates indicate the percentage of spontaneous and operative deliveries and the abscissæ the length of the diagonal conjugate expressed in half centimeters.

Even when delivery is effected spontaneously and without any undue delay, certain characteristic abnormalities can be observed in the mechanism of labor, by which the experienced obstetrician is enabled to recognize the presence of a flat pelvis without resorting to pelvimetry.

Inasmuch as in the varieties of pelves under consideration the contraction is practically limited to the anterior posterior diameter of the superior strait, it is evident that the obstacle to the passage of the child's head must be offered by the shortened conjugata vera; and when this measures less than 9 centimeters it becomes out of the question for the biparietal diameter of the normal head to pass through it, unless it undergoes some diminution in size. Accordingly, when engagement is occurring, the head slips to one side so as to bring the shorter bitemporal diameter in relation with the conjugata vera. As a result the long arm of the head lever becomes displaced to the side of the occiput, so that, under the influence of the uterine contractions, the anterior portion of the head descends, while the occipital portion rises up. Consequently the large fontanel becomes more readily accessible to the examining finger on one side of the pelvis, and the small fontanel less so on the other. At the same time the head tends to accommodate itself to the transverse diameter of the superior strait, so that its long axis, as indicated by the sagittal suture, comes to lie transversely.



Graph showing frequency of spontaneous and operative delivery in the two races, with progressive shortening of the diagonal conjugate.

More characteristic still is the abnormal attitude which the head assumes when the disproportion is at all marked in a flattened pelvis, when we may have what is known as an *anterior parietal presentation.* In this the sagittal suture comes to lie just in front of the promontory of the sacrum, with the result that the head assumes an eccentric position with the anterior parietal bone occupying the greater part of the superior strait. In such circumstances the anterior shoulder is readily distinguished upon external palpation. According to the explanation generally accepted, this condition is brought about by the abnormal relation borne by the axis of the anteflexed uterus to the plane of the superior strait, as the result of which the posterior portion of the head is arrested against the promontory of the sacrum, while its anterior portion is forced into the pelvis.

This presentation is simply an exaggeration of the so-called Naegele's obliquity, and the mechanism of descent is readily understood when we compare the passage of the head through the abnormal superior strait to the maneuver necessary to pass a stick of a certain length through a ring of a somewhat shorter diameter. To do so, one must depress one end so as to allow the stick to enter the ring obliquely, and after it has partially passed its other end will descend without difficulty. Sellheim suggests that this presentation likewise provides a mechanism for effecting a diminution in the transverse diameter of the head. He considers that the sutures are so arranged that one lateral half of the head can be displaced to some extent beyond the other, just as in pushing one half of a jointed oval spring beyond its fellow the greatest transverse diameter will become considerably diminished.

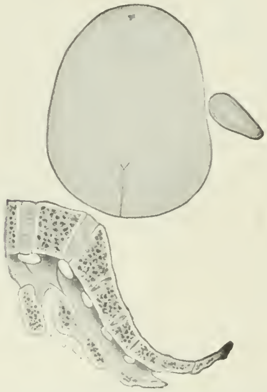


Fig. 647.—Showing Anterior Parietal Presentation.

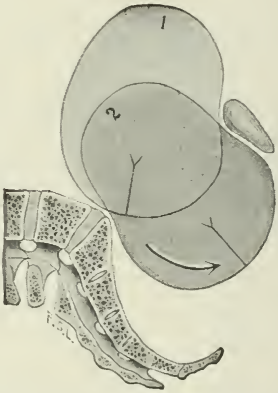


Fig. 648.—Showing the Passage of an Anterior Parietal Presentation through the Superior Strait.

In order for descent to occur, the posterior parietal bone is firmly pressed against the promontory of the sacrum, while under the influence of the uterine contractions the anterior portion of the head is slowly forced down into the pelvis along the internal surface of the symphysis pubis; after this is accomplished the posterior portion passes over the promontory and enters the pelvis, the sagittal suture at the same time moving forward. Accordingly, when the contraction is marked, the posterior portion of the head must be subjected to considerable pressure, as is shown by the presence after birth of a more or less well-defined curved depression, just beyond the coronal suture, upon the side of the head which was in contact with the promontory. After the posterior parietal bone has passed the superior strait, all resistance has been overcome, and owing to the fact that the lower portion of the pelvis is usually relatively large, the rest of the labor is promptly accomplished.

In about one-fourth of the labors occurring in flat pelves, according to Litzmann, the reverse condition—the *posterior parietal presentation*—is observed. The sagittal suture now lies almost in contact with the symphysis pubis, while the posterior parietal bone occupies the superior strait, and in pronounced cases the posterior ear of the child can be felt just above the promontory, so that the condition is sometimes spoken of as an *ear presentation*. The long axis of the child's body forms an obtuse angle with its head, and upon palpation the anterior portion of the latter can be felt as a prominent tumor lying above the symphysis.

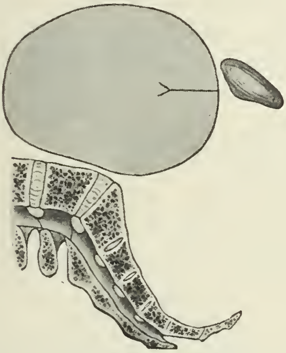


FIG. 649.—SHOWING POSTERIOR PARIETAL PRESENTATION.

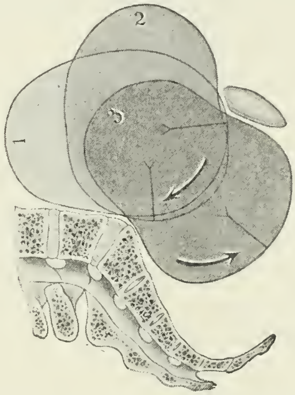


FIG. 650.—SHOWING THE PASSAGE OF A POSTERIOR PARIETAL PRESENTATION THROUGH SUPERIOR STRAIT.

In this event, the head cannot enter the pelvis until its posterior portion is pushed down past the promontory of the sacrum, after which its anterior portion descends along the symphysis pubis, while at the same time the sagittal suture approaches the midline of the pelvis. After this has occurred labor takes place in the usual manner.

The mode of production of this abnormality is not definitely understood, although it is observed most frequently when the grade of contraction is marked, the pelvic inclination considerably increased, and the abdomen not pendulous. It is generally considered as very unfavorable by the Germans, as the line along which the uterine contractions are transmitted is given another direction at the neck, which is much less advantageous than when the spinal column and head form a continuous axis. Tarnier, and Varnier, on the other hand, held that the posterior parietal presentation occurs more frequently than the anterior, and is without ominous prognostic significance. In my experience, however, it is usually indicative of pronounced disproportion, although exceptionally it is not associated with a particularly difficult labor.

When the promontory of the sacrum protrudes into the superior strait in such a way as to render it reniform in outline, it is impossible for the head to assume its usual transverse position, and the sagittal suture must occupy an oblique diameter (Fig. 651). In rare instances the deformity is so great that the superior strait resembles the figure 8. In such circumstances only one side of it is available for the passage of the head, and Breisky has designated the condition as *extramedian engagement*. It naturally serves to exaggerate the degree of disproportion.

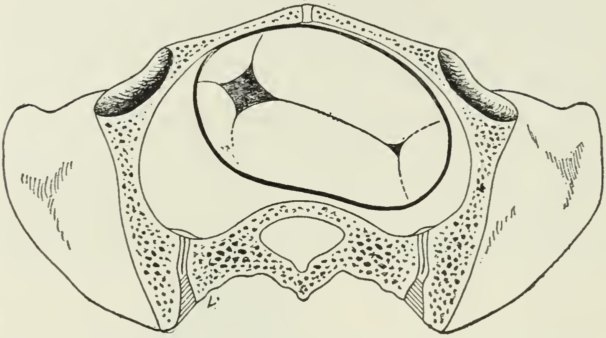


Fig. 651.—Engagement of Head in Reniform Superior Strait (Tarnier).

Breech presentations likewise complicate matters to some extent, as the imperfect adaptation of the breech to the superior strait facilitates prolapse of the cord or of one or more of the extremities. In such circumstances, although the prognosis for the mother remains favorable, the child's life is seriously endangered. This is especially true when the contraction is marked, as great difficulty may be experienced in extracting the after-coming head, which, in passing through the contracted superior strait, follows a mechanism analogous to that observed in anterior parietal presentations. In other words, its posterior portion is arrested at the promontory, while its anterior portion passes down behind the symphysis, after which its posterior portion descends.

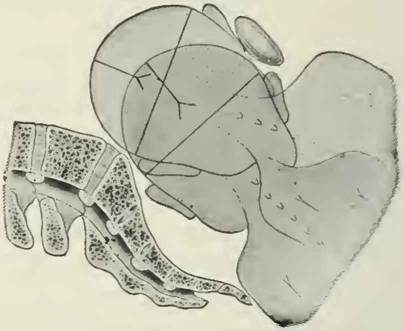


Fig. 652.—Showing Passage of After-coming Head through Superior Strait; Darker Position Last.

In generally contracted flat pelves the mechanism of labor varies according to the extent of the deformity and the shape of the pelvis—that is, according as it approaches more closely to the flat or to the justo-minor type. In the former case, provided the contraction be not too marked, the mechanism of labor will be identical with that just described, whereas in the latter the head will become sharply flexed and be born by the mechanism to be described.

The effect of the generally contracted, or justo-minor, pelvis upon the course of labor is very characteristic. Owing to the fact that all of the diameters of the superior strait are shortened, the head encounters more or less equal resistance from all sides of the pelvic outlet, consequently it enters it in an oblique diameter and in a sharply flexed position, so that on vaginal examination the small fontanel is readily felt, while the large fontanel is almost or quite out of reach. Moreover, as the contraction involves all portions of the pelvic canal, labor is not rapidly completed after the head has passed the superior strait. The prolongation is due not only to the resistance offered by the pelvis, but also in many instances to the faulty character of the uterine contractions, incident to the imperfect development of the uterus, which frequently characterizes such patients.

In the rare pseudo-osteomalacic form, the contraction is usually so pronounced that the child cannot be born *per vias naturales,* and consequently there can be no mechanism of labor. In typical funnel pelves no difficulty is experienced until the head reaches the pelvic floor and attempts to pass through the narrowed pubic arch. The details of this mechanism were considered in the preceding chapter and need not be recapitulated.

COURSE OF LABOR IN CONTRACTED PELVIS

When the pelvic deformity is not absolute, but is sufficiently pronounced to prevent the head from entering the superior strait during the last few weeks of pregnancy, or at the onset of uterine contractions, the course of labor is usually unduly prolonged. In the first stage this is due to imperfect dilatation of the cervix, and in the second to the time required so to mold and configure the head as to render possible its passage through to the pelvic cavity.

Abnormalities in Dilatation of Cervix.—Normally, dilatation of the cervix is brought about by the unruptured membranes acting as a hydrostatic wedge, and after their rupture by the direct action of the presenting part. In contracted pelves, on the other hand, when the head is arrested at the superior strait, the entire force exerted by the uterus acts directly upon the portion of membranes in contact with the internal os, and, consequently, as the force is not broken by the intervening head, as in normal labor, *premature rupture* frequently results, occurring, according to Litzmann, in 26 per cent of the cases, and is frequently followed by intrapartum infection, to which reference will be made on the following page.

After rupture of the membranes, further dilatation cannot take place until the presenting part is able to exert a direct pressure upon the cervix, and this is out of the question until a succession of strong pains have molded the head sufficiently to permit its descent, or have led to the formation of a *caput succedaneum* upon its most dependent portion.

Even after the cervix is completely dilated further delay may occur, and it sometimes requires hours to mold the head to the pelvis. In flat pelves the labor is promptly terminated as soon as the contracted superior strait is passed, whereas in the generally contracted varieties the hindrance persists throughout the entire pelvic canal.

Abnormalities in Uterine Contractions.—In many instances the course of labor is still further prolonged owing to faulty uterine contractions. This is rarely the case in rachitic primiparæ, in whom the pains are usually very efficient; but in multiparæ, in whom previous difficult labors have weakened the uterine musculature, secondary uterine inertia frequently occurs. In women with generally contracted pelves the uterine contractions are frequently inefficient, and this is probably due to the imperfect general development, of which the abnormal pelvis is but a single manifestation.

In prolonged labors, the contractions occasionally become abnormally frequent and severe, so that in extreme cases the uterus becomes *tetanically contracted*. This is an extremely serious condition, as it cannot lead to the termination of labor, but at the same time greatly increases the danger of uterine rupture. If this complication does not yield promptly to the administration of sedatives, it affords an imperative indication for the termination of labor.

Danger of Uterine Rupture.—Abnormal thinning of the lower uterine segment frequently constitutes a very serious danger during a prolonged second stage. When the disproportion between the head and the pelvis is so pronounced that engagement and descent do not occur, the lower uterine segment becomes more and more stretched, and the danger of rupture becomes imminent. In such cases the contraction ring can be felt as a transverse or oblique ridge extending across the uterus somewhere between the symphysis and the umbilicus, while sometimes its position is clearly visible. Thinning of the lower uterine segment is particularly liable to occur in the generally contracted variety of rachitic pelvis, since the lower end of the cervix may be caught between the child's head and the pelvic brim, and thus be prevented from retracting. Whenever this condition is noted prompt delivery is urgently indicated; and, if this is not effected by some type of cesarean section, great caution is necessary on the part of the physician lest his intra-uterine maneuvers give rise to traumatic rupture.

Production of Fistulæ.—When the presenting part is firmly wedged into the superior strait, but makes no advance for a long time, portions of the birth canal lying between it and the pelvic wall may be subjected to undue pressure. As a result the circulation is so interfered with that necrosis follows, which may manifest itself a few days after labor by the appearance of vesicovaginal, vesicocervical, or rectovaginal fistulæ, depending upon the part involved. In former times, when operative delivery was deferred as long as possible, such complications were of frequent occurrence, but at present they are rarely seen except in neglected cases. In general, injurious pressure is unlikely to occur so long as the membranes remain intact, but is liable to follow a very prolonged second stage.

Intrapartum Infection.—Infection is another serious danger to which the patient is exposed in prolonged labors complicated by premature rupture of the membranes, particularly when examined repeatedly by those who do not observe stringent aseptic technic. If the amniotic fluid becomes infected, febrile symptoms appear during labor, while in other cases the micro-organisms pass through the fœtal membranes and invade the uterine walls, giving rise later to the characteristic manifestations of puerperal infection. Intrapartum infection is serious not only for the mother, but is also an important factor in causing intrauterine death of the child. We now know that bacteria can make their way through the amnion and invade the walls of the vessels in the chorionic membrane, and thus give rise to fœtal bacteremia.

In other instances, gas producing bacteria may gain access to the uterine cavity, which soon becomes distended with gas, and presents a peculiar "gurgling" feel to the examining fingers, as well as a tympanitic note upon percussion —*tympanitis uteri* or *physometra*. It usually follows infection with the colon bacillus or with the Streptococcus putridus, although the Bacillus aërogenes capsulatus may sometimes be concerned, particularly when the child is dead. It is always a serious condition and demands prompt termination of labor. For further details the reader is referred to the chapter upon Puerperal Infection.

Rupture of the Pelvic Joints.—In rare instances, particularly when the pelvis is contracted in its lower portion, spontaneous rupture of the symphysis pubis or of one or both sacro-iliac joints has been observed. Such cases have been reported by Ahlfeld, Schauta, Braun von Fernwald, DeLee, Kehrer, and others, though in the majority the injury is produced by injudicious methods of delivery. Kehrer, in 1915, collected from the literature 100 cases of rupture of the symphysis pubis, 17 of which occurred during the course of spontaneous labor. He considers that the predisposing cause for the accident consists in unusual softening or in the development of cavities in the pubic cartilage.

Effect of Labor upon the Child.—So long as the membranes remain intact the child suffers but little from the prolonged labor; but after their rupture, continued uterine contractions may exert a deleterious influence upon it. This is due in great part to interference with the placental circulation, which sooner or later leads to manifestations of asphyxiation. Now and again premature separation of the placenta occurs, causing certain death to the child. Particularly during the second stage of labor, prolonged pressure exerted upon the head is not without influence upon the child, in some cases leading to vagus stimulation with its resulting slow pulse and consequent gradual asphyxiation; while in others death results from intracranial hemorrhage.

Prolapse of the Cord.—A much more serious complication for the child is prolapse of the cord, the occurrence of which is facilitated by imperfect adaptation between the presenting part and the pelvic inlet. The condition exerts no influence upon the course of labor, but unless prompt delivery can be accomplished, death of the child results from compression of the cord between the presenting part and the margin of the pelvic inlet. This must be regarded as a very frequent cause of fœtal death in spontaneous labor in contracted pelves.

Changes in Scalp and Skull.—As has already been stated, a large caput is frequently developed upon the most dependent part of the head, and allusion has been made to the part which it sometimes plays in the dilatation of the cervix. In many instances it may assume very considerable proportions, and lead to serious diagnostic errors. For example, it may reach almost to the pelvic floor while the head is still only partially engaged, so that an inexperienced physician may mistake it for the head itself and be tempted to resort to ill-timed operative measures. After delivery such a caput has no effect upon the child's well-being, as it disappears within a few days after birth.

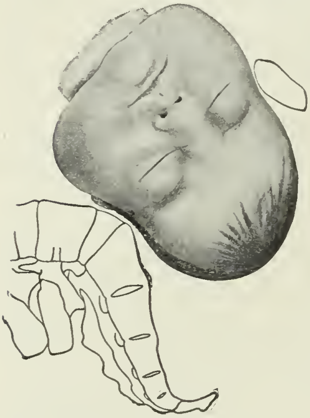


Fig. 653.—Showing Molding of Head in a Generally Contracted Rachitic Pelvis.

When the disproportion between the size of the head and the pelvis is considerable, it is apparent that the former can only pass through after a process of molding and accommodation, which is usually spoken of as *configuration.* In exceptional cases the head may descend into the pelvic cavity comparatively early in pregnancy, and, as it cannot readily escape, it undergoes further development in that position, and in consequence presents characteristic deformities at birth, the part within the pelvis being markedly flattened, while that above is unusually large, as shown in Figure 653.

Under the influence of the strong uterine contractions the various bones comprising the skull come to overlap one another at the various sutures. As a rule the median margin of the parietal bone, which is in contact with the promontory, becomes overlapped by that of its fellow, and the same occurs with the frontal bones. The occipital bone, on the other hand, becomes shoved under the parietal bones, so that the posterior margins of the latter frequently overlap it. These changes are frequently accomplished without detriment to the child, though when the distortion is marked they may lead to tentorial tears, and, when vessels are involved, to fatal intracranial hemorrhage.

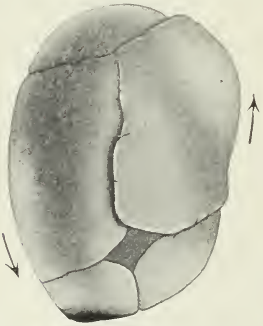


Fig. 654.—Overlapping of Bones of Skull (Tarnier).

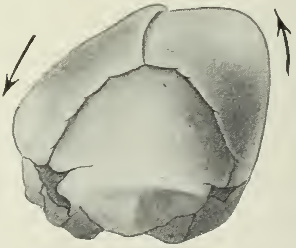


Fig. 655.—Overlapping of Bones of Skull (Tarnier).

Coincident with the molding of the head, the parietal bone, which was in contact with the promontory, may show signs of having been subjected to marked pressure, sometimes becoming very much flattened. Configuration is more readily accomplished when the bones of the head are imperfectly ossified, in rare instances the skull being so soft that it yields to pressure as readily as the shell of a soft crab. This process is of great importance, and serves to explain the difference in the course of labor in two apparently similar cases in which the pelvis and the head present identical measurements. In the one the head is soft and readily molded, so that spontaneous labor can result; in the other the more resistant head retains its original shape, and radical operative interference becomes necessary for its delivery.

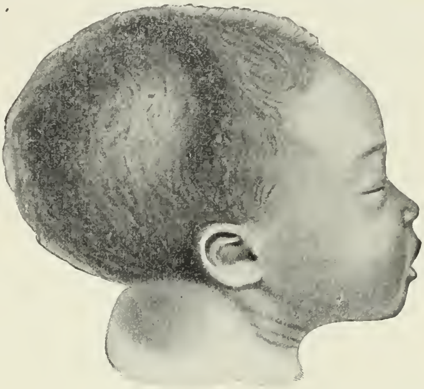


Fig. 656.—Child Born Spontaneously through Generally Contracted Rachitic Pelvis, Conjugata Vera 7.25 Centimeters Showing Caput Succedaneum and Depression of Skull.

Reference has already been made to the *pressure marks* upon the scalp covering the portion of the head which passes over the promontory of the sacrum. These are very characteristic in appearance, and from their location frequently enable one to determine the movements which the head has undergone in passing through the superior strait. Much more rarely similar marks appear on the portion of the head which has been in contact with the symphysis pubis. Such marks have no influence upon the well-being of the child, and usually disappear a few days after birth, although in exceptional instances the pressure may have been so severe as to lead to necrosis and sloughing of the scalp.

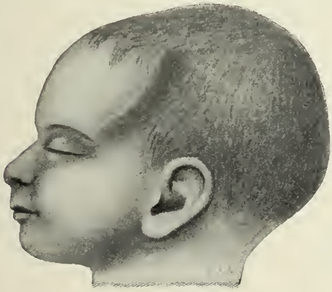


Fig. 657.—Pressure Mark from Promontory.

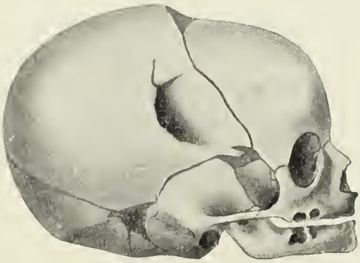


Fig. 658.—Spoon-Shaped Fracture of Skull (Tarnier).

Fractures of the skull are occasionally met with, and usually follow forcible attempts at delivery, though occasionally they may occur spontaneously. The fractures are of two varieties, appearing either as a shallow gutterlike groove or as a spoon-shaped depression just posterior to the coronal suture. The former is relatively common, and, as it involves only the external plate of the bone, is not very dangerous; whereas the latter, if not operated upon, leads to the death of the child in over one-half of the cases; since it extends through the entire thickness of the skull and gives rise to projections upon its anterior, which exert injurious pressure upon the brain. Accordingly it is advisable, as soon as convenient after labor, to elevate or remove the depressed portion of the skull, as may be indicated, in the hope of preventing pressure symptoms, as well as of relieving the effects of hemorrhage.

Prognosis for the Mother.—The prognosis as to the outcome of labor complicated by contracted pelvis depends not only upon the degree of contraction, but also upon the other factors to which we have already alluded. It may be said, however, that spontaneous birth of a fully developed child cannot occur when the conjugata vera measures 7 centimeters or less, and is very unlikely when it measures 7.5 centimeters. Above the latter limit it becomes increasingly frequent as the degree of pelvic distortion diminishes.

In our series of 701 cases studied in 1910, not including funnel pelves, 74.76 per cent of the children were born spontaneously, and the incidence increased to 81.75 per cent when the deliveries by low forceps were deducted, in which the operation had naturally no connection with the pelvic deformity. These results compare very favorably with those of other clinics, as is shown by the following figures:

Valency	69 per cent	Bürger	77.8 per cent
Peham	72.4 per cent	Krönig	78.5 per cent
Bar	76.5 per cent	Baisch	80 per cent

The probability of spontaneous labor decreases rapidly with the degree of pelvic contraction, as is illustrated by the graph on page 915, which shows the percentage of spontaneous and operative delivery in 2242 labors complicated by contracted pelvis and ending in the birth of a live child. It will be noted that the incidence of spontaneous labor was higher and of operative delivery lower in blacks than in whites, which is clearly attributable to the lesser weight, as well as to the smaller and more malleable heads of the black children. It should also be noted that the operative incidence includes operations of every type—even low forceps, which were naturally undertaken after the disproportion between the head and the pelvis had been overcome. Furthermore, it should be noted that the degree of pelvic contraction is indicated by the length of the diagonal conjugate, from which that of the conjugata vera can be approximately calculated by deducting 1.5 or 2 centimeters.

It is generally stated that the probability of spontaneous labor is somewhat less in generally contracted than in flat pelves presenting the same conjugata vera, it being customary to calculate that half a centimeter must be added to the conjugata vera of the former to make it comparable to the latter. In my experience, which is confirmed by Baisch and Zangemeister, this belief is incorrect, and in white women, at least, the prognosis is more serious in simple flat than in generally contracted pelves presenting the same conjugata vera, for the reason that the larger size of the children in the former more than compensates for the theoretically greater difficulty postulated for the latter.

The danger to the mother depends upon the course of labor, the perfection with which aseptic technic is observed, and especially upon the treatment pursued in operative cases. Speaking broadly, the maternal mortality after spontaneous labor should be hardly greater than in normal pelves, if the case is conducted properly. On the other hand, if spontaneous labor does not occur, and the patient is left to herself, she will die undelivered, either from hemorrhage resulting from uterine rupture or from infection. In operative cases the prognosis depends entirely upon the choice of the operation, the surroundings of the patient, and the degree of perfection of the aseptic technic.

In 2274 cases of labor complicated by contracted pelvis, and treated in my service between 1910 and 1924, there were 18 maternal deaths, a gross mortality of 0.79 per cent. Upon deducting the patients who were infected at the time of admission and those who died from such causes as eclampsia, rheumatic endocarditis, influenzal pneumonia, typhoid fever, and late chloroform poisoning, which had no connection with contracted pelvis, there remain six deaths for which we must accept full responsibility—a net mortality of 0.26 per cent. In other words, labor complicated by contracted pelvis, when properly treated has a mortality lower than that associated with the general practice of obstetrics.

Our results compare favorably with those of Bailey, who, in 1926, reported a maternal mortality of 0.42 per cent in 477 cases. Naturally, such results could be obtained only after aseptic technic had become so perfected that radical operations could be undertaken with practical immunity, and after the prenatal care of patients had become so developed that all cases presenting serious disproportion are recognized prior to the onset of labor.

A very instructive comparison between the conditions existing then and now was furnished by Tarnier, who stated that in 334 cases occurring in the Maternité in Paris between the years 1860 and 1869, the maternal mortality was 22 per cent as compared with 1.91 per cent in 1036 cases occurring between 1884 and 1892. In the latter series the mortality was 0.78 per cent in spontaneous, and 5.15 per cent in operative deliveries.

Prognosis for the Child.—The prognosis for the fœtus is always more serious in contracted than in normal pelves, even though labor occurs spontaneously. It likewise depends to a great extent upon the methods chosen for delivery, and, broadly speaking, increases with the degree of pelvic contraction, unless cesarean section is frequently performed. The fœtal mortality prior to 1865 is clearly shown by the following table of Michaelis, Litzmann, and Schwartz:

Conjugata Vera	*Fœtal Mortality*
9.25—8.5 cm.	5.0 per cent
8.4 —7.5 cm.	16.9 per cent
7.4 —7.0 cm.	52.9 per cent

In our series of 2274 cases, just referred to, 286 children were born dead or died within two weeks after delivery, a gross mortality of 12.58 per cent. As we have included all cases in which the child had reached the period of viability, there were naturally many deaths from syphilis, prematurity and general debility, not to mention other causes. Upon deducting all such, there remain 107 fœtal deaths due to the abnormal pelvis or to the operative procedure instituted for its relief, indicating a gross mortality of 4.71 per cent. If, however, we deduct 40 cases in which the child had succumbed before the patient had been admitted to the service, and for which we were in no way responsible, there remain 67 deaths, which represents a net mortality of 2.95 per cent—a figure which indicates that under proper treatment the fœtal death rate actually due to contracted pelvis is relatively small.

TREATMENT OF LABOR COMPLICATED BY CONTRACTED PELVIS

The treatment of labor complicated by contracted pelvis varies according to the degree of contraction, the size of the child, and the history of previous labors. In other words, successful treatment depends primarily upon our ability to determine the extent of the disproportion in the individual case, rather than upon the mere dimensions of the pelvis, no matter how accurately they may be determined. Although, generally speaking, a normally developed full-term child cannot be born spontaneously when the conjugata vera measures 7 centimeters or less, and only exceptionally when it falls below 7.5 centimeters; whereas, interference is rarely required when it measures 9 centimeters or more. In the first group the problem is comparatively simple, whereas in the latter it is ofttimes extremely complex and requires the utmost nicety of judgment for its proper solution.

Conjugata Vera of 7.5 Centimeters or Less.—If the deformity belongs in this category, and is recognized during pregnancy, it should be regarded as an absolute indication for cesarean section, and the patient should be sent to a well-regulated hospital for its performance a few days before the expected date of confinement. Such a procedure will give almost ideal results, and all of the children and over 99 per cent of the mothers should be saved, inasmuch as the maternal mortality following cesarean section, when performed upon healthy women by competent operators at an appointed time, need not exceed that following the removal of uncomplicated ovarian cystomata.

On the other hand, if the condition of the pelvis has not been recognized until the woman is well advanced in labor, the treatment to be pursued will vary with circumstances. If the patient is uninfected, has not been examined repeatedly by the vagina, and is in suitable surroundings, low cervical cesarean section will offer every prospect for saving the child, provided it is in good condition, but the chances for the mother will be somewhat less than if the operation had been done at an appointed time. Whereas, if the patient is infected or in poor condition, or the child is dead or dying, the treatment to be pursued will be determined by the degree of pelvic contraction. If the conjugata vera be above 5.5 centimeters, craniotomy is the operation of choice; but with a measurement below this limit we have to deal with the *absolute indication* for cesarean section, which must be performed, no matter what the condition of the child or the mother, as in such circumstances the delivery of a mutilated child through the natural passages will be impossible, or at least quite as dangerous to the mother as a cesarean section done under unsatisfactory conditions. In infected cases the delivery of the child should be followed by supravaginal hysterectomy, as experience teaches that the results following it are almost as satisfactory as after elective section. Pubiotomy should not be thought of here, as its field of usefulness is limited to pelves in which the conjugata vera exceeds 7 centimeters, and to uninfected women with live children.

Conjugata Vera above 7.5 Centimeters.—Here the question as to the proper treatment cannot be so readily disposed of, since definite rules cannot be laid down, and each case must be considered upon its own merits.

We know in general that spontaneous labor will occur in many of these cases, and that its probability increases progressively with each half centimeter's increase in the length of the conjugata vera. But at the same time it may be difficult to predict what will occur in an individual case, as we have to reckon not only with the degree of pelvic deformity, but also with the size of the child's head, the extent to which it may become molded and compressed, as well as with the character of the labor pains. Moreover, although we can determine the size of the pelvis with considerable accuracy, and that of the child with some accuracy, unfortunately we can form only a very imperfect estimate concerning the other factors; and until methods are devised by which this becomes possible, the treatment of labor complicated by moderate degrees of contraction will remain a difficult problem. Of course, the ideal to be striven for is the attainment of such prognostic proficiency as to be able to determine with certainty before the onset of labor whether the disproportion can, or cannot, be overcome by the unaided efforts of Nature, and in the former event to count confidently upon a spontaneous outcome, or in the latter to perform cesarean section at an appointed time. Naturally, absolute precision is out of the question, but it is nevertheless possible to develop such skill in prognosis that relatively few mistakes will be made.

Methods of Determining the Size of the Head.—Despite the existence of numerous methods devised for determining the actual size of the head, we are still without one that is thoroughly satisfactory.

In multiparous women, important information can occasionally be gained from the character of the heads of the children born in previous labors. If they were large and firmly ossified, it is probable that the child in question will possess a head showing similar characteristics, or it may even be larger, as it is well known that the size tends to increase with the age of the mother.

Again, *Müller's method of impression* often affords material aid. In this procedure, the patient having been anesthetized, the obstetrician seizes the brow and occiput of the child with his fingers through the abdominal wall and makes firm pressure downward in the axis of the superior strait, the effect of which may be controlled by the fingers of an assistant in the vagina. If there be no disproportion, the head will readily enter the pelvis and spontaneous labor may be predicted. On the other hand, the fact that the head cannot be forced into the superior strait does not necessarily indicate that spontaneous labor is out of the question. In such circumstances, we take into consideration the extent to which the head overrides the symphysis pubis: if it is pronounced as in Figure 659, we assume that the disproportion is excessive and resort to elective section before the onset of labor. Whereas, if it is only slight, we subject the patient to the test of labor in the hope that sufficient molding and configuration will occur to permit spontaneous delivery.

Munro Kerr employs the following method, which has the advantage of not requiring the services of an assistant. The obstetrician takes the Pawlik grip of the fœtal head with his right hand and presses it into the pelvis; while, with two fingers of the left hand in the vagina, he feels how the head engages. At the same time the thumb of the left hand feels along the brim and estimates the degree of overlapping.

In Pinard's *palper mensurateur,* the brow and occiput having been grasped by the two hands, the head is moved from side to side, so as to bring it into close contact with the pelvic brim. When this is accomplished, one hand is placed upon the child's neck and the head pushed strongly downward and backward so as to bring its posterior portion into close contact with the promontory. An attempt is then made to insinuate the fingers of the other hand between the anterior surface of the head and the symphysis. If this can be done it indicates that there is no disproportion; but if it is impossible, and the anterior portion of the head forms a tumor which projects over the symphysis pubis, the probabilities are that engagement will not occur.

I rely in great part upon a combination of the methods of Müller and Pinard, and after seizing the head through the abdominal wall, with the thumb over the occipital and the other fingers over the frontal region, make pressure downward in the axis of the superior strait. If the head enters, there can be no serious disproportion, whereas if it overrides the symphysis pubis to any extent disproportion exists, and with practice one learns to estimate its degree, and to differentiate between the cases in which it can be overcome spontaneously and those in which it will be impossible. Figure 659 represents the conditions noted in a patient just prior to the performance of a fourth cesarean section. Naturally the findings at such an examination are valueless until late in pregnancy except where the disproportion is excessive. In doubtful cases it is advisable to examine the patient at weekly intervals throughout the last month.

Ahlfeld believes that the biparietal diameter of the head bears a definite relation to the length of the child, and attempts to measure the latter *in utero.* To do this, one blade of the pelvimeter is placed upon the abdomen over the breech of the child, while the other is introduced into the vagina and applied to the vertex. The measurement thus obtained is taken to represent one half the length of the child, and from this the size of the head is calculated, as shown by the following table:

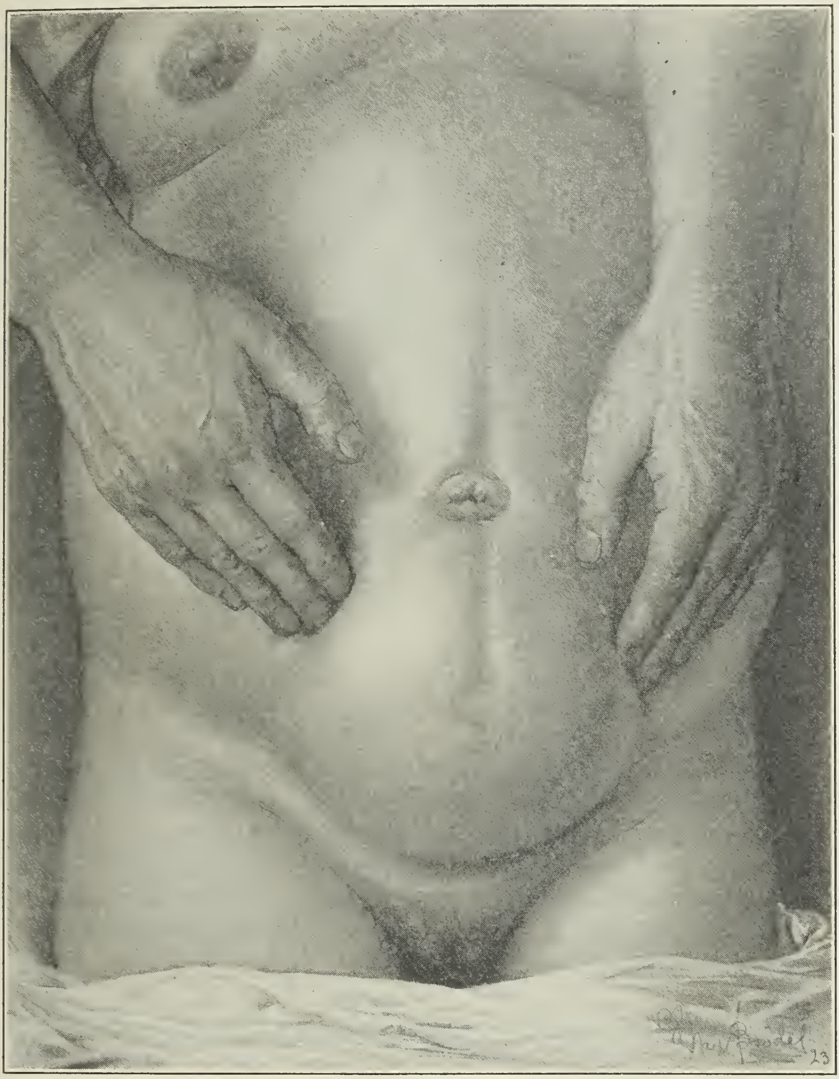


Fig. 659.—Method of Determining Degree of Disproportion by Ascertaining the Extent to Which the Head Overrides the Symphysis.

Length of Child, Cm.	*Biparietal Diameter, Cm.*
50	9.06
49	8.72
48	8.56
47	8.44
46	8.34

Perret, in 1899, and McDonald, in 1906, recommended measuring the fronto-occipital diameter of the head through the abdominal walls, and then estimating from it the length of the biparietal diameter. Perret devised a special cephalometer for the purpose, while McDonald attaches the tips of an ordinary pelvimeter to the index and second fingers of either hand by means of strips of adhesive plaster. The former estimates the length of the biparietal by subtracting 2.5 centimeters from the measurement so obtained, while the latter contends that the amount to be subtracted averages 2.33 centimeters, but varies according to the length of the fronto-occipital diameter. Such figures, however, represent only the average obtained from the measurements of a number of children, but do not necessarily hold good for any given case, and in my hands have given such uncertain results that I have ceased to employ them.

Fronto-occipital Diameter, Cm.	*Amount to be Subtracted, Cm.*
10.00	1.00
10.50	1.55
10.75	1.81
11.00	1.91
11.25	2.07
11.50	2.26
11.75	2.50
12.00	2.30
12.25	2.35
12.50	2.50
12.75	3.12

On the other hand, the methods of Müller, Kerr, and Pinard give us valuable information. But in the cases of moderate disproportion, in which information is most desired, they give no clue as to the consistency of the head nor of the extent to which it may become molded. Information as to this point can be gained only by watching the course of labor during the second stage; but, unfortunately, if the decision that the disproportion is too great to be overcome spontaneously is not made until that period, the optimum time for the performance of elective cesarean section will have already passed.

Conjugata Vera from 10 to 9 Centimeters.—For convenience in considering the treatment of labor when the conjugata vera exceeds 7.5 centimeters, it is advisable to differentiate between pelves in which the conjugata vera varies between 10 to 9 centimeters; and those in which it falls below that limit.

Spontaneous labor is the rule in the first category, unless the head is unusually large or the expulsive forces are very deficient, since a moderate-sized head will usually become molded sufficiently to pass through the contracted superior strait. Accordingly, in pelves of this character the course of labor should be left to Nature as long as possible, and interference resorted to only when absolutely necessary. In most cases the head becomes engaged and then descends into the pelvis after an hour or so of second-stage pains, or at least becomes sufficiently molded to permit the safe application of mid-forceps.

On the other hand, if engagement fails to occur after complete dilatation of the cervix, certain authorities recommend that the patient should be placed in Walcher's position for as long a time as she will bear it. In many cases this procedure will bring about a lengthening of the anteroposterior diameter of the superior strait sufficient to permit engagement. As soon as the head has descended into the pelvis, the patient should be placed upon her back, as the hanging position tends to contract the pelvic outlet and thus retards delivery. In my experience, however, this is rarely successful, so that if engagement does not promptly occur the treatment outlined in the following section should be adopted.

If the child should die during the course of labor, craniotomy should be resorted to without hesitation, as it is safer for the mother than the application of high forceps.

Conjugata Vera 9 to 7.5 Centimeters.—It is in "border-line" pelves contracted within these limits that the greatest difficulty is experienced in predicting the course of labor and in laying down rules for treatment. More than one-half of such patients will be delivered spontaneously, the number decreasing as the lower limit is approached; but it is often impossible to foretell what will occur in a given case. Consequently, the patient should be examined most carefully at the end of pregnancy for the purpose of determining the existence and degree of disproportion. If it is clearly evident that the child's head will not engage, or if the history of previous labors renders it probable that a spontaneous termination is out of the question, cesarean section should be performed at an appointed time. On the other hand, if the disproportion appears to be so moderate that it is reasonably certain that a second stage of average intensity

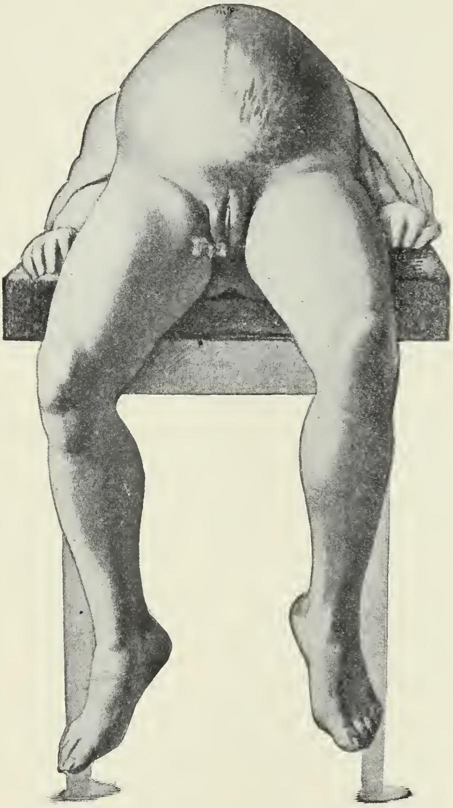


FIG. 660.—WALCHER'S HANGING POSITION (Bumm).

will bring about such configuration that the head will enter the pelvis, the patient should be subjected to the "test of labor" in the hope that delivery will occur spontaneously. It should always be remembered in this type of case that the ideal is to be able to differentiate before the onset of labor between the patients who require cesarean section and those in whom spontaneous labor can occur. Whenever a tentative course is pursued, the most rigorous aseptic technic should be employed, and the progress of labor followed by palpation and rectal touch, internal examination being restricted as far as possible. If the condition of the pelvis has been ascertained before labor, a vaginal examination need not be made, unless some emergency arises, or the second stage is unduly prolonged. The fœtal heart, of course, should be auscultated at frequent intervals.

The term "test of labor" is employed very loosely. Some writers consider that it has been made if engagement fails to occur after a few hours of first stage pains; others, such as Bailey, set a fixed limit of a certain number of hours of strong pains. I, however, do not consider that the test has been really applied unless the effect of labor has been observed for an hour or two after the cervix has become fully dilated and the membranes have ruptured, as experience teaches that it is only in such circumstances that engagement occurs and the head really becomes molded.

In a large number of cases spontaneous delivery will occur after a test of labor; but if the prognosis has been incorrect, and the head shows no tendency to descend after several hours of efficient second-stage pains, a spontaneous termination can scarcely be hoped for, and it then remains to determine what will be the most desirable method of delivery.

If the patient is in a well-regulated hospital, and the head is still above the superior strait, and shows no sign of engaging, low cervical cesarean section gives almost ideal results, provided the patient shows no signs of intrapartum infection.

On the other hand, if the patient be in a tenement house and refuses to enter a hospital, or is in the country where the physician cannot command the necessary assistance and appliances for an aseptic operation, the second stage should be allowed to continue until the appearance of definite signs of danger on the part of the mother or child. Occasionally spontaneous labor will occur contrary to all expectation. Failing such a fortunate outcome, high forceps should be applied obliquely to the head and a few tractions made. If the head shows a tendency to advance, they should be persisted in, but if not, the instrument should be removed and craniotomy performed. In such cases forceps should be employed only *tentatively,* it being understood that its employment is generally contra-indicated, and that prolonged traction and brutal methods of extraction are not permissible, as by their means the child is almost as surely lost as by craniotomy, while the life of the mother is unnecessarily endangered.

Of course, if the patient is a devout Catholic, the well-known views of that Church concerning craniotomy must be recognized, and the physician may be called upon to perform a radical operation when, from a purely professional point of view, its justifiability might be open to criticism. In all but the slightest grades of contracted pelvis, craniotomy should be performed whenever the child has died during the course of labor, as any other operation subjects the mother to increased danger for the purely sentimental consideration of not mutilating the child.

Furthermore, if the patient has not been seen until far advanced in labor, and has been repeatedly examined by persons not skilled in aseptic technic, or if she presents symptoms indicative of a beginning infection, conservative, or even low cervical, cesarean section is contra-indicated on account of their very high mortality in such circumstances. If, however, the patient is very anxious for a living child, cesarean section followed by supravaginal hysterectomy is justifiable, as experience shows that the results following it are excellent. It should always be remembered that this operation entails permanent sterility, so that in making a decision some thought should be exercised as to the future. Consequently, the operation will be resorted to more frequently in multiparæ. If this is not done, tentative attempts at delivery with forceps should be made, and if these fail craniotomy should be performed. Not a few authorities advise extraperitoneal cesarean section under these conditions, but in my opinion the results obtained are by no means commensurate with the added risk to which the patient is subjected.

If the line of treatment which we have outlined for hospital practice be rigorously carried out, the fœtal mortality will hardly exceed that occurring in normal labor, while the maternal mortality will be reduced to a minimum. On the other hand, when the forceps is employed tentatively and is followed by craniotomy in unsuccessful cases, the fœtal mortality will be very high, but the danger to the mother will be only slightly increased.

Breech and Face Presentations in Contracted Pelves.—The existence of a breech presentation in moderate degrees of pelvic deformity should be regarded as a complication especially unfavorable for the child, inasmuch as in the early stages of labor prolapse of the cord is facilitated, and in the later stages serious delay may be encountered in the extraction of the after-coming head, which is almost uniformly followed by the loss of the child. Moreover, as the head is not in contact with the superior strait, it is difficult to determine the degree of disproportion. For these reasons, one is justified in being much more liberal in the indications for elective cesarean section. On the other hand, if the patient is not seen until late in labor, and presents any considerable disproportion, I have sometimes placed the Gigli saw prophylactically before attempting extraction. If the head passes the superior strait without difficulty, all is well; but, if not, the pubis should be sawed through, after which delivery can be readily effected. In my hands, this procedure has proved very satisfactory, and has given me a sense of security which was previously lacking.

So far as the mother is concerned, breech presentations are rather favorable, for the soft breech does not subject her soft parts to such injurious pressure as the hard head; and if delivery becomes imperative, extraction can usually be accomplished without excessive difficulty, unless the pelvic contraction is very marked, but the fœtal mortality will be high.

In frank breech presentations, when the pelvis is but slightly contracted and there is reason to believe that interference will become necessary, it may be advisable, as a prophylactic measure, to bring down one foot soon after rupture of the membranes, so that extraction can be effected promptly when indicated.

Face and brow presentations should be regarded as much more serious complications, as their existence usually indicates a considerable degree of disproportion and an increased probability of operative interference. If the pelvic contraction is at all serious, too much should not be expected from Nature, and radical measures should be instituted early in labor. On the other hand, when one feels fairly satisfied that the disproportion is not excessive and can be overcome, an attempt should be made to convert the presentation into a vertex by one of the recognized procedures.

Use of Forceps in Contracted Pelves.—Generally speaking, the employment of high forceps is contra-indicated, and especially so in contracted pelves when the head is freely movable above the superior strait; as the failure to engage after several hours of efficient second-stage pains indicates that the disproportion is too great to be overcome. In such cases forcible attempts to drag the head through the pelvis will lead to fatal injury of the child, and frequently to the death or to serious lesions on the part of the mother. Too many cases in hospital and consultation practice abundantly bear out the truth of this assertion. On the other hand, after the head has become well molded and is fixed at the pelvic brim, the tentative application of forceps is justifiable. If, however, a few tractions are not followed by descent, the obstetrician must be prepared to resort to craniotomy, rather than to a major operation.

When the greatest circumference of the head has passed the superior strait, the employment of forceps is governed by the same rules as in normal pelves, for in such cases the operation is not performed on account of the contracted pelvis, but for one of the usual indications.

Version in Contracted Pelves.—Formerly, version was frequently recommended as a satisfactory method of delivery in contracted pelves, and many authorities compared its advantages with those obtained with the forceps.

Sir James Y. Simpson pointed out that the after-coming head offered more favorable conditions than the vertex for passing through a contracted pelvis, as smaller diameters are the first to encounter and overcome the resistance offered by the superior strait, while the greatest circumference of the head is subjected only to momentary compression during extraction. But although version undoubtedly presents some advantages so far as the mother is concerned, these are more than counterbalanced by the dangers to which it exposes the child. Thus, Lichtenstein stated that the fœtal mortality in 154 operations performed in Leopold's clinic, from 1901 to 1905, was 26.62 per cent. Moreover, the advantages of version are markedly diminished by the fact that it must be performed soon after rupture of the membranes if satisfactory maternal results are to be obtained.

Formerly, many of the German authorities recommended the performance of so-called *prophylactic version*—turning at the onset of the second stage—in all cases of moderate disproportion. This practice does not appear justifiable for several reasons. In the first place, it does away with the possibility of the test of labor and converts all into operative cases; in the second place, if the operation is performed at the most favorable time, just after the rupture of the membranes, the head has had no chance of becoming molded, and accordingly it must be dragged through the pelvis with only such diminution in size as results from a few minutes' traction. Moreover, a mistake in the estimation of the degree of disproportion always results in fœtal death; since if any serious obstacle is experienced, only a few minutes can elapse between the birth of the umbilicus and the extraction of the head, and in this event sufficient time is not available to permit of any other operation being performed in the hope of saving the child.

Induction of Premature Labor.—In the past, when the mortality from cesarean section was excessive, many authorities recommended the induction of premature labor at the thirty-fourth or thirty-sixth week of pregnancy in moderate degrees of pelvic deformity, in the expectation that the smaller and softer head would be born more readily than at term. This is undoubtedly the case, and the operation, if properly performed, should have a maternal mortality of well under one per cent. Consequently, arguments in its favor must stand or fall according as the fœtal mortality is low or high. Furthermore, it must be remembered that the question is not solved by the number of living children which are discharged from the hospital, but is also dependent upon their fate during the first year of life; as it must be expected that the mortality will be higher than in children who began life with normal weight and full development. Finally, it must be borne in mind that the procedure is adapted only to the more moderate degrees of pelvic contraction, in which experience teaches that a test of labor is usually followed by spontaneous birth at term.

Until recently, the immediate and remote fœtal mortality following induction was so high that most heads of clinic abandoned it in favor of the expectant treatment described in the preceding pages, and restricted its use to the so-called postmature child. As I hold a similar view, I have never induced labor for this indication, and do not expect to do so, unless its advocates are able to adduce more convincing evidence in its support.

On page 926, it was pointed out that a gross fœtal mortality of 12.58 per cent was noted in 2274 labors complicated by all degrees of contracted pelvis, which were delivered in my service between the years 1910 and 1924. In this series the mortality actually due to contracted pelvis was only 4.71 per cent, which became reduced to 2.95 per cent upon deducting the children which were dead when the patient came into our hands. Moreover, the entire operative incidence for the series was 15.5 per cent. In other words, 84.5 per cent of the patients were delivered spontaneously. At the same time, it should be borne in mind that such results were accomplished only by free use of cesarean section (64.43 per cent of all of our operations), either as an elective procedure when marked disproportion was recognized late in pregnancy, or as an emergency operation when a "test of labor" had demonstrated that the degree of disproportion had been underestimated. In the first group induction would rarely have been indicated, whereas in the second the course of events demonstrated that it would have been a technical error. My own experience confirms the conclusions of Baisch concerning the great value of expectant treatment in contracted pelvis. In his exhaustive study he clearly demonstrated that the results for the child improve as the use of high forceps, prophylactic version and induction of labor is restricted, while at the same time the maternal mortality is not increased. In my hands not only was the mortality for the child decreased, but that for the mother was diminished nearly four times.

In 1908, Norris, who is one of the strongest advocates of induction of labor in this country, reported a primary fœtal mortality of 13 per cent. Since 1925, various authorities have taken up the question anew, and have attempted to solve the problem by sharpening the indications for operation. Thus, Zangemeister, and Banister no longer induce labor at an arbitrarily fixed time, but only after careful and repeated examinations have shown that the head has attained such proportions that it can no longer enter the pelvis. Zangemeister, in this way, obtained a primary fœtal mortality of 6 per cent, but at the same time estimated that one-third of the children discharged alive from the clinic would perish during the first year of life. Banister, in 1926, reported 745 inductions from his service with a primary fœtal mortality of 13.3 per cent. This it is seen somewhat exceeds our gross mortality, but his results must be regarded as still more unfavorable, for the reason that no one would think of induction unless the mother and child were in good condition at the time, and such a restriction would exclude many cases in which fœtal death had occurred in our series.

Furthermore, it should be borne in mind that induction destroys all possibility of a test of labor, and thus tends to increase greatly the frequency of operative interference. That this is not a mere supposition, was shown by Connan and Jones who, in 1927, studied critically the outcome of 123 labors induced in the Maternity Division of the City of London Hospital. They concluded that the interference had been unnecessary in 46 per cent of their cases, as was shown by the fact that the size of the children had been overestimated or that in subsequent labors the patient gave birth spontaneously to children definitely larger than those born following induction.

Accordingly, it appears both from my personal experience, as well as from a review of the literature, that intelligent expectant treatment, including meticulous prenatal care, reduces the total number of operations and definitely diminishes both fœtal and maternal mortality. This, however, means a large number of cesarean sections, which in our service constituted nearly two-thirds of our operative procedures. On the other hand, it permitted the occurrence of spontaneous labor in approximately 85 per cent of our patients, which would have been out of the question had any other course been pursued.

To my mind, the claims of the advocates of the induction of premature labor may be disposed of by a *reductio ad absurdum*—namely, that better fœtal results could be obtained by allowing all patients in whom it appears indicated to go to full term and performing craniotomy whenever spontaneous labor does not occur. For this reason it seems to me, whenever the induction of premature labor is frequently employed, that it must in many instances have been resorted to unnecessarily.

On the other hand, in patients presenting moderate degrees of pelvic contraction without serious disproportion, labor should be induced as soon as the calculated end of pregnancy has been reached, as it seems irrational to stand idly by and to watch the child increase beyond the usual limits of size. In such cases, labor should be induced by Watson's method, or, if it fails, by the introduction of a bougie. This, however, is not the induction of premature labor, but rather the termination of pregnancy after the child has attained full maturity.

In conclusion, it cannot be too forcibly impressed upon the student that the repeated delivery of dead children in cases of contracted pelves is unjustifiable. The loss of a single child may frequently be perfectly excusable, but its repeated occurrence indicates a neglect of human life which should not be tolerated, and physicians should learn that it is their duty, if they do not feel competent to cope successfully with such cases, to send them to a well-regulated hospital or to confide them to the care of a competent specialist for treatment.

TREATMENT OF LABOR COMPLICATED BY OSTEOMALACIC PELVES

The course of labor in osteomalacic pelves varies according to the stage of the disease and the degree of contraction. When the deformity is slight its influence upon the labor is minimal, but when marked it frequently gives an absolute indication for cesarean section.

Some idea of the obstacle offered to labor by this class of pelves may be gained from the figures of Litzmann, which were collected in 1861, at a time when the mortality attending cesarean section was so appalling that the operation was undertaken only under the most pressing indications. He tabulated 79 cases from the literature, and found that the following operations had been performed: 40 cesarean sections, 16 perforations, 1 symphyseotomy, 2 inductions of premature labor; while 7 women had succumbed to rupture of the uterus, and 4 others had died undelivered.

Latzo, in 1897, considered the effect of osteomalacia upon the course of labor in 85 patients who came under his observation. These women had gone through 290 labors before, and 169 after, the appearance of the disease. In the first group operative interference was necessary once in every 48 cases, and in the second once in every 4.9 cases—in other words, labor had become ten times more difficult.

If the patient is seen during the early months of pregnancy and is suffering from the disease in its acute stage, she should be at once removed to a hospital where she can live under the best hygienic surroundings and be supplied with an abundance of suitable food. Phosphorus or adrenalin should be administered tentatively. Latzo, Winckel, and others state that the former in doses of 2.4 to 4 milligrams per day frequently leads to a permanent cure; while Bossi and others make similar claims for the curative properties of the latter. Benzel and others claim that the use of the x-ray is sometimes followed by surprising results; while Maxwell and Miles hold that cod liver oil acts almost as a specific.

If tentative treatment is not satisfactory, or the patient is not seen until the end of pregnancy or the time of labor, the treatment to be pursued depends altogether upon the degree of pelvic contraction. In such cases attention should be paid not only to the length of the conjugata vera, but more particularly to the dimensions of the inferior strait. In florid cases the bones may be so soft as to resemble leather in consistency, and the pelvis readily assumes various forms. This affords an explanation of the fact that one is occasionally surprised to see delivery accomplished through a pelvis which at first glance appears to offer no possibility of such an occurrence. Quite a number of such cases are recorded in the older literature, but such an outcome should be regarded as exceptional, and should not lead us to expect too much of Nature.

If the pelvis is markedly contracted cesarean section should be performed without hesitation, followed by the removal of the uterus and ovaries, or by castration alone. Fehling has shown that either of these operations leads to the permanent cure of the disease in about 80 per cent of the cases, and Seitz, in 1913, collected 328 cases with 87 per cent of cures. If, however, delivery occurs spontaneously, or has been effected by forceps or version, castration should be performed during the puerperium in the hope of checking the disease.

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CHAPTER XXXVII

PELVIC ANOMALIES DUE TO DISEASE OF THE VERTEBRAL COLUMN

KYPHOTIC PELVIS

History.—Kyphosis or humpback, the result of spinal caries, plays an important part in the production of pelvic abnormalities, for when situated in the lower portion of the vertebral column it is usually associated with a characteristically funnel-shaped distortion.

We are indebted to Rokitansky for the first accurate work upon the subject, although as early as 1759 Madame Boursier de Coudray reported a cesarean section performed upon a patient having a pelvis of this character.

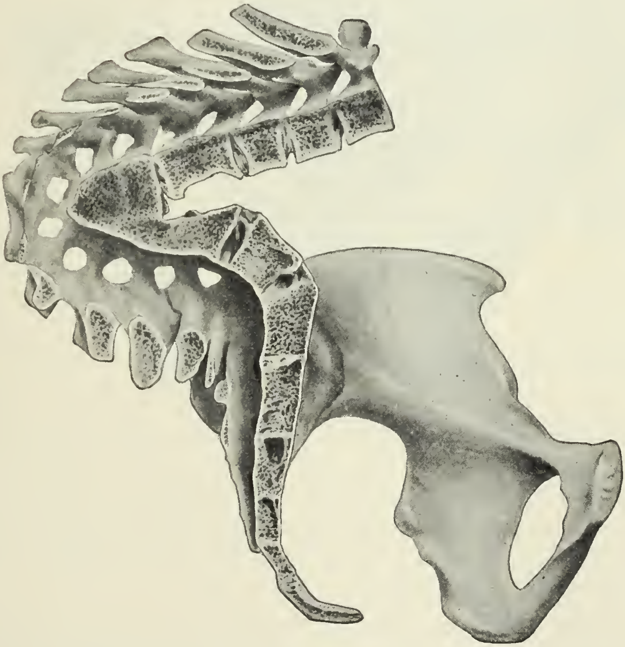


FIG. 661.—LONGITUDINAL SECTION THROUGH PELVIS AND SPINAL COLUMN IN DORSOLUMBAR KYPHOSIS (Breus and Kolisko).

The most important contribution to our knowledge concerning the kyphotic changes was made by Breisky (1865), who clearly set forth the mechanical factors by which the alteration in shape was brought about. Later, Chantreuil, Champneys, Barbour, Treub, and particularly Breus and Kolisko added materially to our knowledge of the subject.

The effect exerted upon the pelvis by kyphosis differs according to its location. When the gibbus or hump is situated in the dorsal region, it is usually compensated for by pronounced lordosis beneath it, so that the pelvis itself is but little changed. On the other hand, when situated at the junction of the dorsal and lumbar portions of the vertebral column its effect upon the pelvis becomes manifest, and is still further accentuated when the kyphosis is lower down, being most marked when it is at the lumbosacral junction.

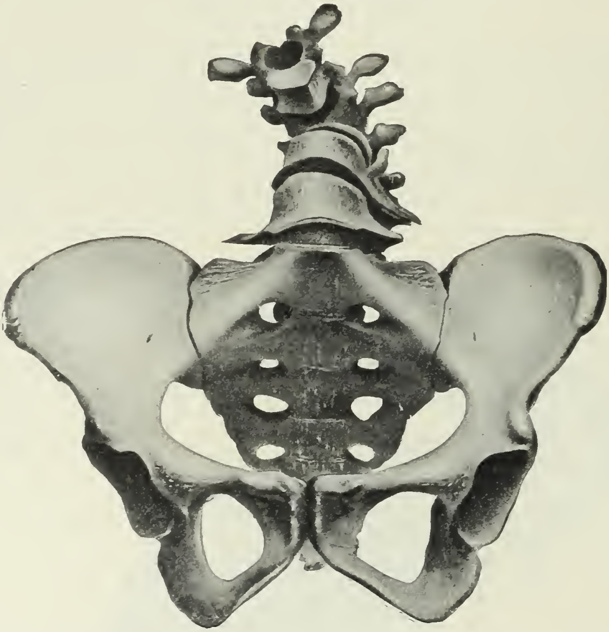


Fig. 662.—Kyphotic Pelvis Showing Elongation of Conjugata Vera.

Klien analyzed 85 cases reported in the literature, and found that the kyphosis was dorsolumbar in 24, lumbar in 17, and lumbosacral in 37 cases, while in 7 other cases the vertebral column so overhung the superior strait as to produce a *"pelvis obtecta"* (Fig. 663).

Characteristics.—The characteristic feature of the kyphotic pelvis is a retropulsion and rotation of the sacrum, by which the promontory becomes displaced backward and the tip forward. At the same time the entire bone becomes elongated vertically, and narrowed from side to side. These changes are associated with a rotation of each innominate bone about an axis, which extends through the symphysis pubis and either sacro-iliac articulation, so that the iliac fossæ become flared outward while the lower portions of the ischial bones are turned in toward the middle line.

When the kyphosis is in the dorsolumbar region, marked lordosis below it indicates an attempt at compensation, but as this is imperfect the body weight is transmitted to the sacrum in such a manner that the latter becomes retroposed and lengthened, its promontory being farther backward and at a higher level than usual. At the same time its anterior surface loses its normal vertical concavity and becomes straight or even convex; while its lateral concavity is obliterated by the projection of the vertebral bodies beyond their alæ. The bodies themselves are considerably narrower than usual, and the alæ of the first sacral vertebra appear to be drawn out and to extend obliquely upward to the promontory.

Owing to its backward displacement the posterior surface of the sacrum approaches the superior posterior spines of the ilium, thereby relaxing the iliosacral ligaments. As a result the posterior extremities of the innominate bones are pushed apart, and their upper portions rotate outward and the lower portions inward, so that the crests are flared out and occupy a lower level than usual, while the ischial spines and tuberosities approach the middle line. This tendency is still further accentuated by the increased tension exerted by the iliofemoral ligaments resulting from a diminution of the pelvic inclination. The acetabula also are shifted slightly and look more to the front than usual. Coincident with the displacement of the sacrum, the iliopectineal line becomes longer, particularly in its iliac portion.

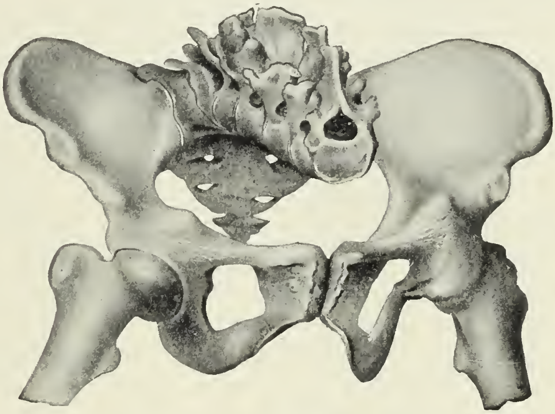


FIG. 663.—PELVIS OBTECTA (Fehling).

These changes give rise to a funnel-shaped pelvis, in which, as the result of the increased length of the conjugata vera, the superior strait becomes round or oval in shape, with the long diameter running anteroposteriorly, while the transverse diameter remains unchanged or may even be shorter than usual. There is also a gradual diminution of all the anteroposterior diameters of the pelvis below the superior strait, but the most characteristic change is the shortening of the distance between the ischial spines, and to a somewhat less extent of that between the ischial tuberosities.

In 18 kyphotic pelves described by Breus and Kolisko the conjugata vera varied from 10.7 to 16.5 centimeters in length, the distance between the spines from 5.2 to 8.2 centimeters, and that between the ischial tuberosities from 6 to 12.1 centimeters. At the same time it should be remembered that in not a few cases the entire cavity is smaller than usual, Klien having pointed out that 30 per cent of all kyphotic pelves which he studied were also generally contracted, so that a conjugata vera which at first glance appears normal may in reality be relatively increased in length.

When the kyphosis is situated at the junction between the last lumbar and the first sacral vertebræ, the pelvic changes are more marked than those just described, as the promontory of the sacrum is usually carious and takes part in the formation of the gibbus. In such cases there can be no attempt at compensation, as the body weight is transmitted directly to the anterior surface of the sacrum, so that its upper part is pushed far backward. It is not lengthened, and its alæ are usually very small. In such cases the transverse contraction becomes still more marked, so that the distance between the ischial spines may be reduced to 3 or 4 centimeters, as in the cases described by Schroeder and Doktor. The pelvic inclination is always diminished, and in some cases is entirely obliterated.

In such cases, the lumbar vertebræ may so overhang the superior strait as effectively to prevent the child's head from entering it. This condition was described by Fehling as *pelvis obtecta*. In his specimen the distance between the symphysis pubis and the nearest point on the vertebral column was 3.8 centimeters. A similar condition was noted in 8 per cent of the cases analyzed by Klien, and has been described by Herrgott as *spondylizème*.

Mode of Production.—A kyphosis in the dorsal region is usually compensated for by a marked lordosis below it, so that the body weight is transmitted to the sacrum in the usual manner. On the other hand, as Breisky pointed out, when the hump is situated lower down, the body weight is transmitted through its upper limb, and on reaching the gibbus becomes resolved into two components, one of which is directed downward and the other backward. This latter force draws the promontory of the sacrum backward and upward, thus leading to rotation and elongation of the entire bone (Fig. 664).

Breus and Kolisko have shown that, owing to the necrosis of one or more of the vertebral bodies forming the gibbus, the body weight is not transmitted directly through the vertebral bodies below it, but through their arches and spinous processes. As a result the latter come into close contact, while the anterior portions of the vertebræ become widely separated, thus leading to pronounced lordosis beneath the gibbus. This causes an upward drag upon the bodies of the sacral vertebræ, which become stretched and elongated. Coincident with the backward displacement of the sacrum, as well as from the increased tension exerted by the iliofemoral ligaments, the innominate bones likewise undergo vertical rotation, which brings about a narrowing of the lower portions of the pelvis.

Frequency.—According to Klien's statistical study a kyphotic pelvis is met with once in every 6016 labors, although he himself believes that this estimate is too low, in view of the fact that humpbacked women are relatively numerous. On the whole, it is probable that any one who has an extensive obstetric practice is likely to meet with this abnormality.

Diagnosis.—The diagnosis is usually easy, as the external deformity is readily visible and should at once suggest the possible existence of a funnel pelvis.

External pelvimetry is of great value, as in pronounced cases it shows that the distance between the iliac crests is equal to or exceeds that between the trochanters, whereas normally the reverse is true. Consequently, in a patient suffering from this deformity, lines drawn through the iliac crests and trochanters will meet somewhere in the neighborhood of the feet, instead of near the head as is the case in normal women.

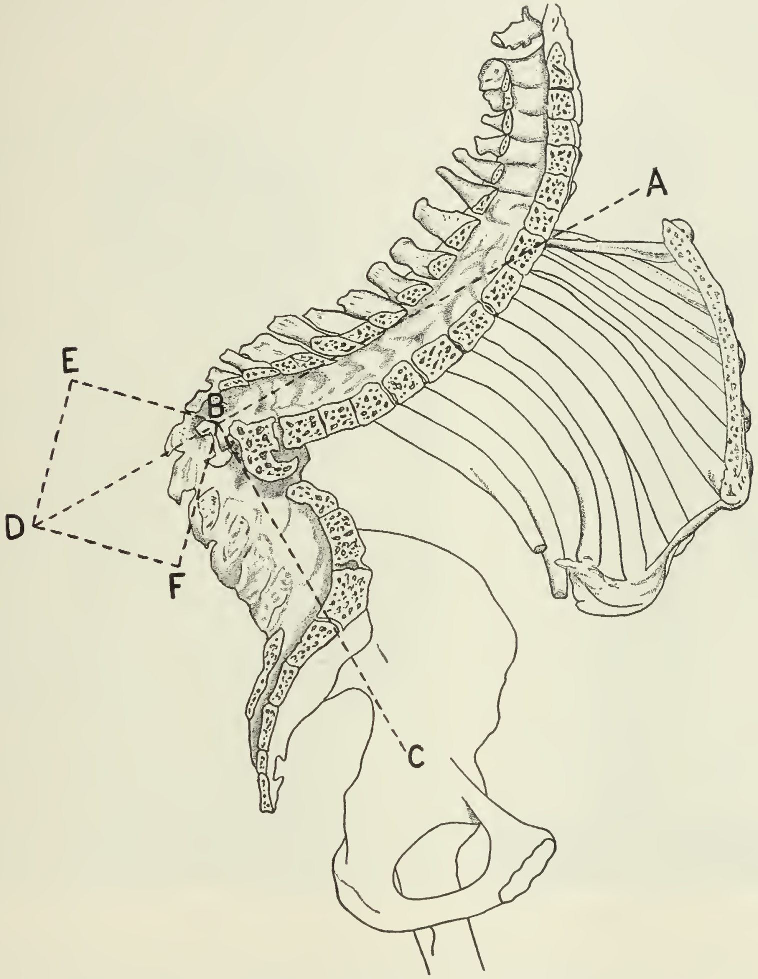


Fig. 664.—Diagram Showing Forces Concerned in the Production of Kyphotic Pelvis (Tarnier).

On palpation of the pubic arch the transverse narrowing of the pelvic outlet will be noted, while internal examination will reveal the lengthening of the conjugata vera. In lumbosacral kyphosis the promontory no longer exists, and the bodies of the lower lumbar vertebræ overhang the superior strait. Accordingly, in this type of deformity particular attention should be devoted to the length of the "pseudoconjugate"—the distance from the upper margin of the symphysis pubis to the nearest portion of the vertebral column. Occasionally the condition may be confounded with spondylolisthesis, and the differential diagnosis will be considered under the latter heading.

Effect upon Labor.—Owing to the collapse of the vertebral column, the ribs approach the pelvic brim and thereby lessen the capacity of the abdomen, which in consequence becomes markedly pendulous at an early period of pregnancy. As a result serious dyspnea may develop, and is usually due to purely mechanical conditions, but in other instances it is associated with changes to which the term "kyphotic heart" is applied. In this condition, to which Klien has redirected our attention, and which is due to obstruction in the pulmonary circulation, there is great hypertrophy of the right side of the heart, which is usually associated with severe myocardial change, but with little or no valvular change.

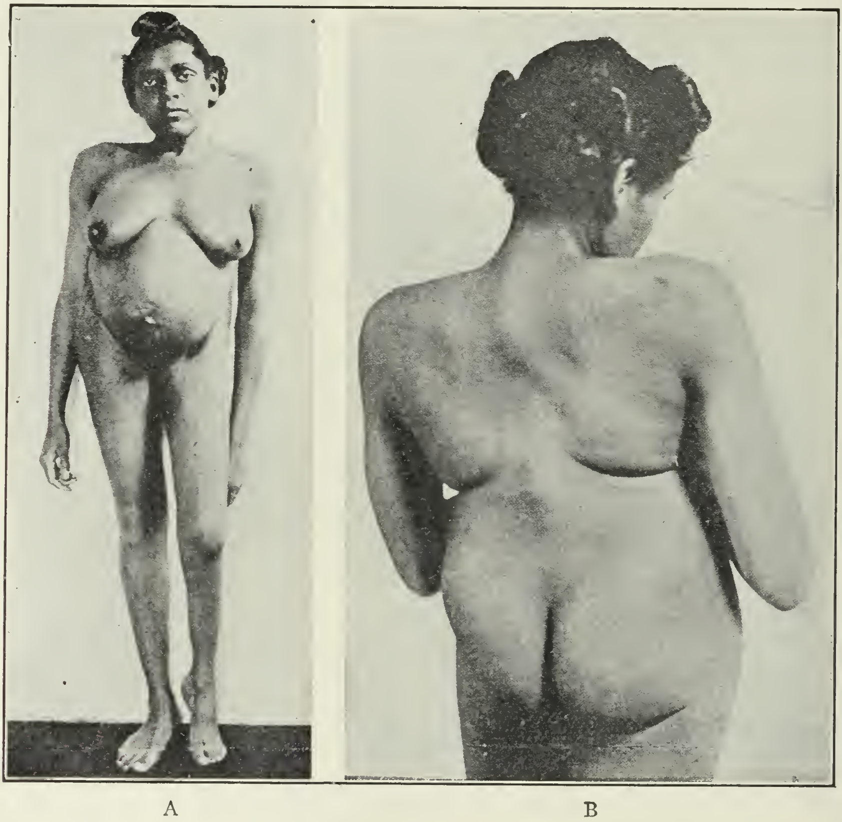


Fig. 665.—Patient with Obliquely Contracted, Kyphotic, Funnel Pelvis.
In *A* note that body weight is borne by right leg. In *B* note presence of double gibbus. The lumbosacral one is concerned in producing the funnel pelvis.

The mechanical conditions favor the occurrence of abnormal positions of the fœtus, and Klien, in 100 longitudinal presentations, found 90 vertex, 4 face, and 6 breech presentations.

It is interesting to note that left occipito-anterior presentations occur in only one-third of the cases, while in the other two-thirds right anterior and posterior presentations are encountered with equal frequency. It is difficult to give a satisfactory explanation for the unusual frequency of the right anterior position, but the production of posterior positions is attributed to the pendulous abdomen, as in such circumstances the concave ventral surface of the child tends to apply itself to the convex inner surface of the anterior wall of the uterus.

Except in pelvis obtecta, or in patients presenting a very pendulous abdomen, the presenting part experiences no difficulty in entering the superior strait at the time of labor, and no obstacle is met with until it reaches the neighborhood of the ischial spines. If the transverse contraction in that locality is not too marked to prevent descent, further difficulty is encountered when the head reaches the pelvic outlet, for owing to the approach of the tubera ischii, the pubic arch has become more angular than usual, so that the head is prevented from filling it out and must descend lower than usual in order to be born. This fact readily explains the deep perineal tears so frequently observed.

Generally speaking, it may be said that when the distance between the tubera ischii is less than 8 centimeters labor becomes difficult or impossible, according to the degree of transverse contraction of the outlet. In such cases the dystocia is more pronounced than in typical funnel pelves presenting identical measurements, for the reason that the anterior displacement of the tip of the sacrum is inevitably associated with shortening of the posterior sagittal diameter. Owing to the narrowing of the pubic arch, occipito-anterior are less favorable than occipitoposterior presentations, as in the latter, the smaller brow accommodates itself to the pubic arch instead of the wider biparietal diameter. According to Klien, face presentations are still more favorable for the same reason.

Prognosis.—If the contraction is pronounced, the prognosis is bad for both child and mother unless cesarean section is resorted to. Klien has analyzed the histories of 175 labors occurring in 95 women, and found that 40 per cent of the children died. The maternal mortality varied according to the degree of contraction; when the disproportion between the biparietal diameter of the child's head and the distance between the spines was slight, it was 6.2 per cent, as compared with 17 per cent in marked cases.

Neugebauer has likewise analyzed the histories of 199 labors occurring in 118 women, and found that only 44 ended spontaneously. The maternal mortality was 24.3 per cent, and 49 per cent of the children died.

In view of the serious prognostic significance of the kyphotic heart, Klien recommends whenever signs of decompensation appear, that pregnancy be interrupted without too much regard for the child.

Treatment.—When the distances between the spines and tuberosities of the ischium do not fall below 8 centimeters, spontaneous labor, or at least a probable delivery with low or mid forceps, can be looked for, provided the posterior sagittal diameter is not too shortened; but when the measurements are below this limit operative interference becomes necessary. Unless the child is very small, elective cesarean section is the operation of choice. If, however, the patient is not seen until late in labor, and the child is already dead, craniotomy is indicated.

KYPHORACHITIC PELVIS

Kyphosis is nearly always of carious origin, but when due to rachitis it is usually associated with a greater or lesser degree of scoliosis. In the rare cases of pure rachitic kyphosis, however, the pelvic changes are slight, as the effect of the kyphosis is counterbalanced to a great extent by that of the rachitis, the former leading to an elongation and the latter to a shortening of the conjugata vera, while tending, respectively, to narrow and to widen the inferior strait. Thus it may happen that a woman presenting a markedly deformed vertebral column of this character may have a practically normal pelvis. The two processes, however, do not always counteract each other, and, as a rule, when the kyphosis is high up the pelvic changes are predominantly rachitic.

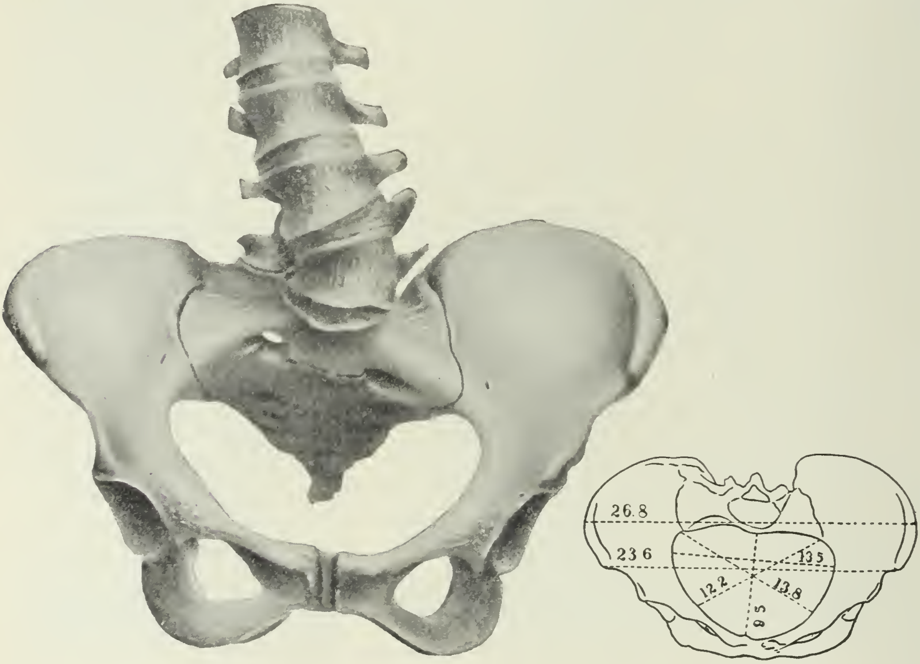
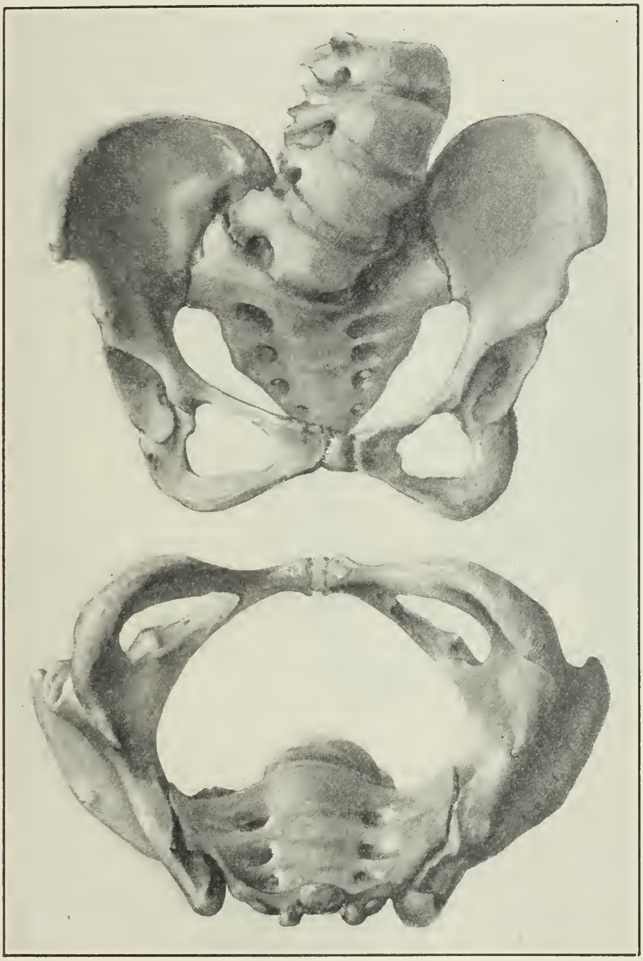


Fig. 666. Fig. 667.

FIGS. 666, 667.—OBLIQUELY CONTRACTED NONRACHITIC SCOLIOTIC PELVIS (Breus and Kolisko).

SCOLIOTIC PELVIS

Pronounced scoliosis, or lateral curvature of the spine, is usually of rachitic origin; but minor degrees of the deformity are often observed which have no connection with rickets. When the scoliosis involves the upper portion of the vertebral column, it is usually compensated for by a corresponding curvature in the opposite direction lower down, thus giving rise to a double or S-shaped curve. In such cases the body weight is transmitted to the sacrum in the usual manner, so that the pelvis is not implicated. But when the scoliosis is lower



Figs. 668, 669.—Sciolorachitic Pelvis Showing (Upper) Very Contracted Superior, and (Lower) Greatly Widened Inferior Strait.
Note that sacral assimilation of right side of fifth lumbar vertebra had played a considerable part in causing the scoliosis.

down and involves the lumbar region, the sacrum takes part in the compensatory process and accordingly assumes an abnormal position which leads to slight asymmetry of the pelvis.

Breus and Kolisko have devoted particular attention to the pelvic anomalies resulting from nonrachitic scoliosis, but the changes in shape are usually so slight as to have little or no effect upon the course of labor.

When due to rachitis, the scoliosis may be very pronounced, and give rise to marked pelvic deformity, in which the characteristic changes due to the anomaly of the vertebral column are superadded to those resulting from rachitis. In such cases the scoliotic convexity is usually directed to the right side, as was noted in 7 out of the 9 cases described by Leopold. Occasionally, unilateral assimilation may accentuate the process, as in Figure 668, in which the right transverse process of the fifth lumbar vertebra has taken on sacral characteristics, while the left side has remained unchanged.

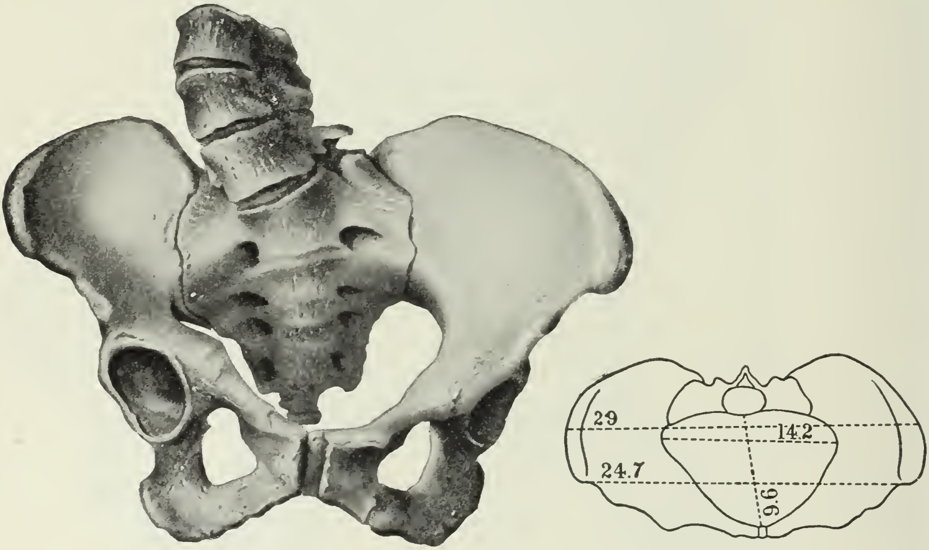


Fig. 670. Fig. 671.

Figs. 670, 671.—Kyphoscoliorachitic Pelvis (Leopold).

In such circumstances the sacrum takes part in the compensatory scoliosis, one side being compressed and the other elongated, so that its long axis becomes directed obliquely toward one side. At the same time it undergoes a partial rotation about its vertical axis, the spinous processes being directed toward the compressed side, a result which indicates the abnormal direction along which the body weight is transmitted to the iliac bones, and thence to the femurs. Owing to the abnormal pressure exerted upon one side, the pelvis becomes obliquely contracted, usually upon the side corresponding to the lumbar convexity; but, owing to the coexistence of rachitic changes, the contraction is in great part limited to the superior strait.

Occasionally, owing to the pressure exerted upon the compressed side of the sacrum, ankylosis at the sacro-iliac articulation may occur. At the same time the innominate bone on the affected side is displaced upward, inward, and backward, while its acetabulum looks more forward than usual. The symphysis pubis is brought somewhat nearer to the opposite side, and owing to the rachitic changes the pubic arch is widened, while the tubera ischii flare outward instead of inward as in the Naegele pelvis. In pronounced cases the superior strait assumes an obliquely ovate appearance, and occasionally the acetabulum on the affected side may come almost in contact with the promontory.

The location of the contraction can be determined by external examination, as it always lies upon the side toward which the convexity of the scoliosis is directed. In extreme cases, the contracted side is valueless from an obstetrical narrowed. If, however, the head manages to pass through it, no further difficulty is experienced in its downward course, owing to the rachitic widening of the lower portion of the pelvis.

KYPHOSCOLIOTIC PELVIS

In this type, the distortion of the pelvis will vary according as the kyphosis or the scoliosis is the predominant factor in the deformity of the spinal column. When the former is more pronounced the pelvis will partake of the kyphotic character, and vice versa. When the two deformities are approximately equal, however, the kyphotic changes in the pelvis predominate, although the influence of the scoliosis tends to counteract, to a certain extent, the transverse narrowing of the inferior strait.

KYPHOSCOLIORACHITIC PELVIS

This variety of pelvic deformity has been studied more particularly by Leopold, and Barbour. As has already been pointed out, a kyphosis due to rachitis is nearly always complicated by a scoliosis and the latter usually predominates in the production of the pelvic deformity, for the reason that the kyphosis and the rachitis tend mutually to counteract each other in their effect upon the pelvis. Accordingly, the resulting pelvis does not differ materially from that observed in scoliorachitis, except that the tendency to anteroposterior flattening is partially counteracted by the action of the kyphotic vertebral column. Nevertheless, owing to the presence of the scoliosis, the oblique deformity of the superior strait is usually quite marked. Generally speaking, this class of pelvis is more favorable from an obstetrical standpoint than that due to scoliorachitis alone.

SPONDYLOLISTHETIC PELVIS

The term spondylolisthesis (from *σπονδυλος*, vertebra, and *ολισθησις*, slipping or sliding) was introduced by Kilian, in 1853, in describing a pelvis in which the last lumbar vertebra had become displaced downward over the anterior surface of the sacrum.

Characteristics.—The degree of displacement may vary greatly. When the deformity is slight the anterior inferior margin of the last lumbar vertebra merely projects a short distance beyond the anterior margin of the promontory of the sacrum; while in pronounced cases the entire body of the vertebra is displaced downward and forward into the pelvic cavity, so that its inferior surface comes in contact with, and more or less completely covers, the body of the first, and occasionally that of the second sacral vertebra. As a consequence, a greater or lesser portion of the lumbar column comes to occupy the upper portion of the pelvic cavity, the superior strait becoming markedly obstructed and assuming a reniform shape.

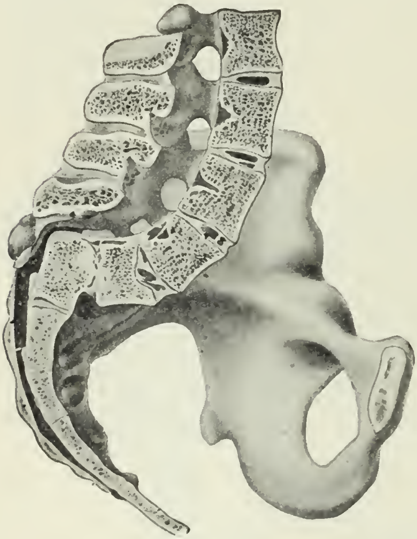


Fig. 672.—Vertical Section through Spondylolisthetic Pelvis (Kilian).

The lower lumbar vertebræ may overhang the pelvic inlet to such an extent that the obstetrical or pseudoconjugate will be represented by a line drawn from the upper margin of the symphysis to the lower margin of the fourth, third, or even of the second lumbar vertebra, as the case may be. In the specimen which I described in 1899, it extended to the lower margin of the third lumbar vertebra and measured 6.5 centimeters. The displacement of the last lumbar vertebra is due not to luxation, but to the lengthening and bending of its interarticular portions. Its inferior articular processes still retain their normal relation to the superior articular processes of the first sacral vertebra, whereas its body and its superior articular processes, together with the rest of the vertebral column, becomes displaced forward and eventually downward. As a result of the new position assumed by the body of the last lumbar vertebra, the superior and anterior surfaces of the promontory become worn away by friction, the defect being frequently followed by ankylosis which definitely checks further displacement. In advanced cases the inferior articular processes of the last lumbar and the superior articular processes of the first sacral vertebra are usually firmly synostosed together, as are also the inferior articular processes of the fourth and the superior articular processes of the fifth lumbar vertebra.

Owing to the collapse of the vertebral column into the pelvic cavity, the center of gravity falls in front of instead of just behind the acetabula, and consequently the pelvis must be tilted backward in order that the individual may retain an upright position. In other words, the pelvic inclination must be diminished, and when the deformity is marked the plane of the superior strait becomes parallel to, or even forms an obtuse angle with, the horizon. This is rendered possible by changes in the iliofemoral ligaments, which are manifested on the one hand by a marked roughening of the portions of the pelvis to which they are attached, and on the other by characteristic changes in the gait of the patient. In my own case the pelvic inclination was obliterated; but, had it remained normal, the vertebral column would have formed a right angle with the legs, necessitating the patient's going upon all fours, although, as a matter of fact, she was able to walk erect.

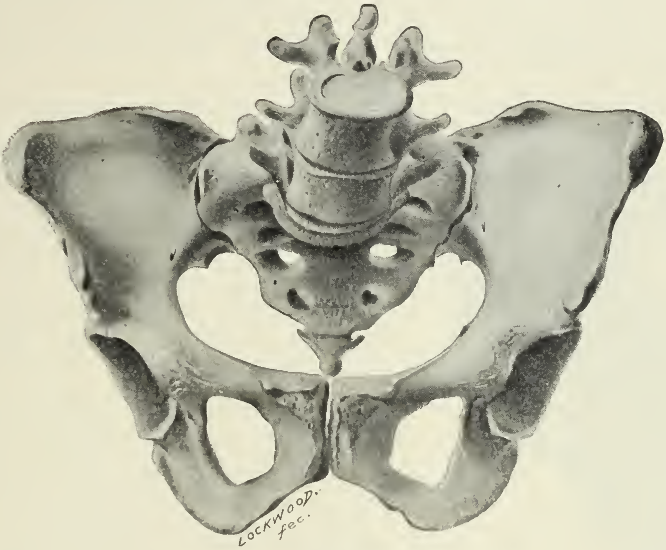


Fig. 673.

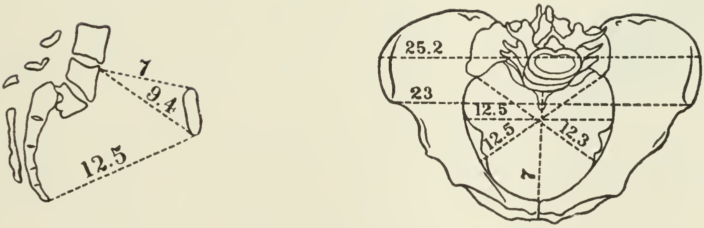


Fig. 674. Fig. 675.

Figs. 673-675.—Williams' Spondylolisthetic Pelvis.

As the inferior surface of the last lumbar vertebra is in contact with the anterior instead of the superior surface of the first sacral vertebra, the action of the body weight tends to force the promontory of the sacrum backward, thereby causing it to rotate about its transverse axis, so that its tip approaches the lower margin of the symphysis pubis. This rotation, together with the increased traction exerted by the iliofemoral ligaments, causes each innominate bone to rotate about an axis extending from the symphysis to the sacro-iliac joint, and tends to give the pelvis a funnel shape, just as in kyphosis, the inferior strait becoming contracted both transversely and anteroposteriorly.

Etiology.—Kilian considered that the displacement of the last lumbar vertebra was rendered possible by inflammatory softening of the intervertebral disk. Later, various hypotheses were advanced as to its mode of production. Robert, Lambl, and Königstein showed that the displacement could not take place so long as the inferior articular processes of the last lumbar were normal and in contact with the superior articular processes of the first sacral vertebra, unless the entire vertebra became lengthened.

Neugebauer devoted thirteen years (1882-1895) to the study of this subject, and during that period published 15 journal articles and 3 monographs upon it, covering nearly 900 pages, not to mention the discussions and demonstrations in which he took part. He showed conclusively that in the vast majority of cases the deformity was rendered possible by a lengthening and thinning out of the interarticular portions of the last lumbar vertebra, by which its superior and inferior articular processes become separated by a long, thin lamina of bone instead of being almost in the same vertical line (Fig. 677).

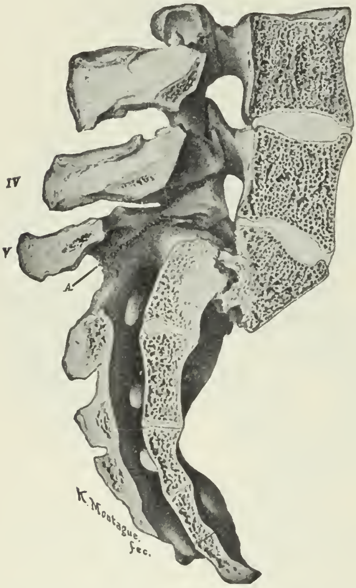


Fig. 676.—Spondylolisthesis; Vertical Section through Last Three Lumbar Vertebræ and Sacrum. × ½.

This condition he attributed to imperfect development of the interarticular portion (spondylolysis) or to its fracture, with subsequent stretching of the callus. He considered that the former was the more frequent cause, as he was able to demonstrate it in many vertebræ which presented no signs of spondylolisthesis. Hayek stated that spondylolysis may occur in any part of the vertebral column from the atlas downward, and on careful search can be detected in every fortieth vertebral column. When the displacement is marked in the last lumbar vertebra, the interarticular portion is not only lengthened and thinned out, but also becomes bent over the promontory of the sacrum, thus forming a *dolicho-kyrto-platyspondylus*.

In opposition to Neugebauer's statement that the deformity always results from changes in the interarticular portion, Chiari has shown that it can occasionally follow fracture of the articular processes without the characteristic changes in the vertebra. At the same time, he considered that spondylolysis is the usual cause. Goldthwait holds that the deformity is usually due to luxation of the inferior articular processes of the last lumbar vertebræ over the superior articular processes of the sacrum. In this event, the spinal canal would be encroached upon and the cauda equina compressed, with resulting paralysis. The absence of the latter complication in most pronounced cases of spondylolisthesis argues against the correctness of his theory, and in favor of Neugebauer's view, according to which the elongation of the interarticular portion of the last lumbar vertebra would lead to an increase in the size of the spinal canal, and thus lessen the probability of pressure upon the cauda.

Arbuthnot Lane stated that the disease is more common than is generally supposed, as he observed several examples of it in coalheavers. He considers that in such cases, at least, the changes in the interarticular portion are due not to abnormalities in development but to excessive pressure, which results from carrying heavy burdens. Bowman states that moderate degrees of the deformity are frequently detected on x-ray examination of the pelvis. Complete literature upon the subject will be found in my own article, and those of Breus and Kolisko, and Chiari.

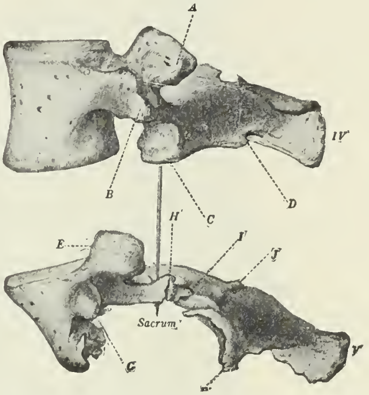


Fig. 677.—Fourth and Fifth Lumbar Vertebræ from Author's Case of Spondylolisthesis. × ½.

A, superior articular process; *B*, transverse process; *C*, inferior articular process; *D*, lamina of fourth lumbar vertebra; *E*, superior articular process; *F*, inferior articular process; *G*, transverse process; *H*, *I*, *J*, fissures in interarticular portion of last lumbar vertebra.

Frequency.—Neugebauer, in 1893, was able to collect 115 cases of spondylolisthesis, most of which were clinical observations. In 1899, I collected 123 cases, which Chiari, in 1912, increased to 150, including 17 cases occurring in males—11.3 per cent. According to Breus and Kolisko, only 20 indisputable anatomical specimens of this condition were in existence in 1900, including 2 which they described for the first time.

Effect upon Labor.—When the condition is but slightly marked, its effect upon labor is similar to that of a flat pelvis, as the greatest contraction is in the conjugata vera, although it should be remembered that it is likewise associated with considerable contraction of the inferior strait. When the deformity is pronounced and the lower lumbar vertebræ overhang the superior strait, the degree of contraction, from an obstetrical point of view, is to be reckoned not by the distance between the symphysis pubis and the anterior portion of the last lumbar vertebra, but by the length of the pseudoconjugate, whose posterior extremity may be at the fourth, third, or even second lumbar vertebra, and in many cases is so short as absolutely to preclude the possibility of the head entering the pelvis.

Diagnosis.—In typical cases mere inspection of the patient should lead one to suspect the existence of this deformity, inasmuch as there is always marked lumbar lordosis and the entire trunk seems to have caved in, so that the ribs may come almost in contact with the iliac crests. When viewed from the front the abdominal walls appear unusually redundant. Such patients have a peculiar ducklike or waddling gait, to which Neugebauer first directed attention. Since the posterior portion of the last lumbar vertebra retains its normal position while the rest of the vertebral column sinks forward, its spinous process will sometimes form a marked prominence just above the sacrum. The condition, however, may be confounded with a deep-seated kyphosis.

On internal examination the diagnosis, as a rule, is readily made, as, on attempting to measure the diagonal conjugate, the body of the last lumbar vertebra will be found lying in front of the anterior and upper portion of the sacrum. At the same time the iliopectineal line ends abruptly at the margins of the overhanging vertebral body, instead of continuing uninterruptedly to the promontory of the sacrum.

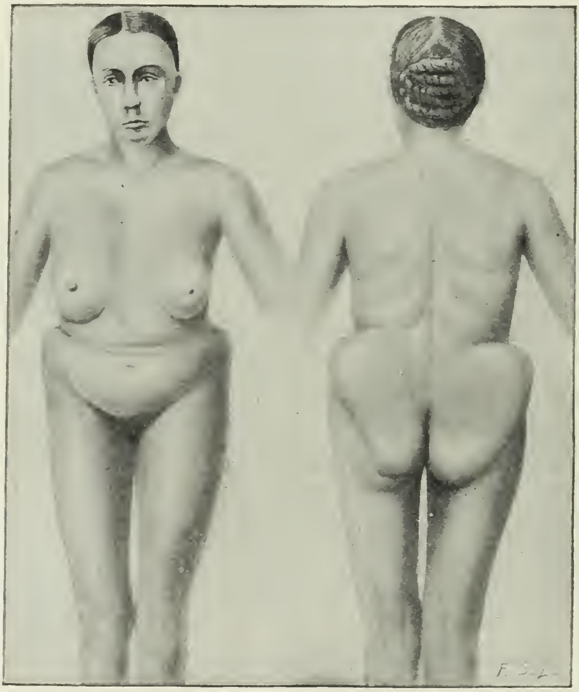


Fig. 678.—Front and Back Views of Woman with Spondylolisthesis (Ahlfeld).

Owing to the marked lordosis, which frequently accompanies the condition, the bodies of the lower lumbar vertebræ can readily be palpated and counted, and the bifurcation of the aorta, or at least the common iliac arteries, are frequently readily accessible to the examining finger.

Occasionally pronounced rachitic changes in the sacrum may simulate spondylolisthesis, but a correct diagnosis can usually be arrived at. In such cases, careful palpation, under anesthesia if necessary, will show that the iliopectineal lines terminate at the promontory of the sacrum instead of at the sides of the prolapsed body of the last lumbar vertebra.

A somewhat similar condition is presented in certain cases of lumbosacral kyphosis, particularly in the pelvis obtecta. Under such circumstances the promontory of the sacrum is destroyed, but a correct diagnosis can usually be made by carefully palpating the anterior surface of the sacrum and tracing the alæ to the body of the first vertebra, which, of course, is impossible in spondylolisthesis.

The x-ray is a valuable aid in diagnosis. Particularly in slightly developed cases, it may make possible the recognition of a displacement of the last lumbar vertebra too slight to be detected clinically, as happened in a patient shown me by my associate, John G. Murray, Jr.

Prognosis.—Generally speaking, spontaneous labor can occur only when the deformity is minimal, and accordingly, in pronounced cases the outlook is uniformly bad for both mother and child unless radical operative measures be undertaken. Other things being equal, a spondylolisthetic pelvis offers a worse prognosis than a rachitic one with the same anteroposterior measurements, for the reason that in the former the inferior strait is also contracted, while in the latter it is usually enlarged.

In considering the probable outcome of labor, one should measure the pseudoconjugate with particular care, inasmuch as it usually offers the greatest obstacle to labor. The fact that a patient with spondylolisthesis has had one or more spontaneous labors does not necessarily imply that the labor in question will be uneventful, for the reason that the degree of deformity frequently increases with age, as happened in my own case.

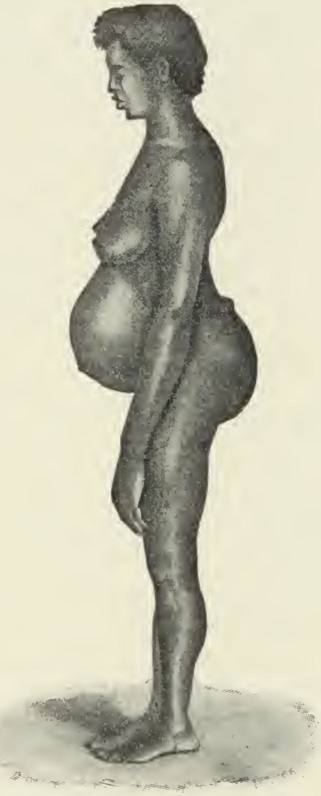


Fig. 679.—Side View of Author's Spondylolisthetic Patient, Showing Projecting Spine of Last Lumbar Vertebra.

Treatment.—With a pseudoconjugate of more than 8 centimeters, the possibility of spontaneous labor should be borne in mind; but when it falls below that limit, cesarean section should be done at an appointed time. In slight degrees of contraction, in which spontaneous delivery has failed to occur, the propriety of pubiotomy may be considered; but in Morisani's case, as well as in my own, symphyseotomy proved fatal.

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CHAPTER XXXVIII

PELVIC ANOMALIES RESULTING FROM THE ABNORMAL DIRECTION OF THE FORCE EXERTED BY THE FEMORA—ATYPICAL DEFORMITIES

Normally, in the case of an individual standing erect, the upward and inward force exerted by the femora is of equal intensity on either side, and is transmitted to the pelvis through the acetabula. In walking or running the entire body weight is transmitted alternately first to one and then to the other leg. On the other hand, in a person suffering from disease affecting one leg, the sound one has to bear more than its share of the body weight, and consequently the upward and inward force exerted by the femur is, as a rule, greater upon that side of the pelvis. To these mechanical factors are due the changes in shape which accompany certain forms of lameness, provided that the lesion, which gives rise to the latter, appears at an early period of life while the pelvic bones are still in a formative state.

The defect may be either unilateral or bilateral; in the former case it is usually due to coxitis, luxation of the femur, infantile paralysis, or shortening of one leg from various causes, while in the latter case common causes are luxation of both femora and double clubfoot. These conditions have been studied in detail by Prouvost, in whose article, as well as in the chapters of Tarnier and Budin, and of Breus and Kolisko upon the subject, full literature is to be found.

PELVIC DEFORMITIES DUE TO UNILATERAL LAMENESS

Coxalgic Pelvis.—*Coxitis* occurring in early life nearly always gives rise to an obliquely contracted pelvis. If the disease makes its appearance before the patient learns to walk, or if the child is obliged to keep to its bed for a prolonged period, the entire organism may suffer from imperfect development, which also manifests itself in the pelvis and leads to the production of the generally contracted, or justo-minor type, to which are added the mechanical effects and atrophic changes resulting from the unilateral disease. These are manifested by imperfect development of the diseased side of the pelvis, the innominate bone being smaller than its fellow and the iliopectineal line forming the arc of a circle having a smaller radius than upon the well side. At the same time, the sacral alæ are less developed upon the affected side, and the entire bone is somewhat rotated about its vertical axis, so that its anterior surface looks toward the well side (Fig. 680, A and B).

When the individual begins to stand, the body weight is transmitted in great part to the well leg, owing to the actual shortening of the diseased leg or to fear of placing it firmly upon the ground. As a result, the pelvis becomes obliquely tilted, being higher on the well side, and a compensatory scoliosis appears. At the same time, the upward and inward force exerted by the normal femur tends to push that side of the pelvis upward, inward, and backward, whereby the iliopectineal line is markedly flattened and the asymmetry of the sacrum still further increased, thus giving rise to an obliquely contracted pelvis. The contraction is not limited to the superior strait, but likewise involves the lower portion of the pelvis, the spine and tuberosity of the ischium being displaced toward the midline.

Not uncommonly these changes are accompanied by irritative processes at the sacro-iliac articulations, which may eventually lead to ankylosis. As a general rule, the oblique contraction is to be found on the well side of the pelvis, but, according to Tarnier, and Briggs, the reverse is the case when the affected leg is ankylosed in a position of adduction and internal rotation (Fig. 681).

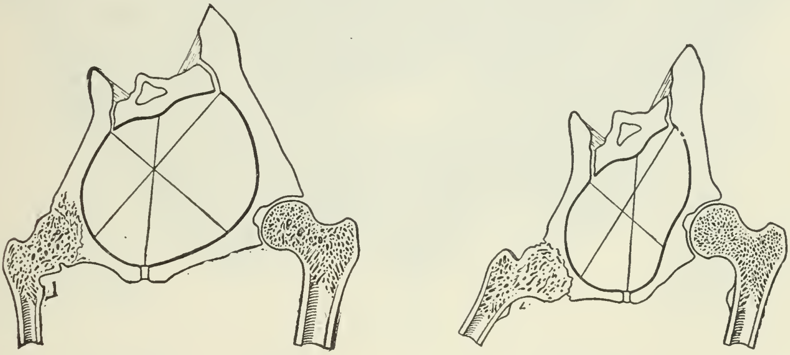
A B

Fig. 680.—Diagram Showing Coxalogic Pelvis, A, before and, B, after the Individual Has Walked.

Oblique contraction of the pelvis may also develop when *unilateral luxation* of the femur occurs in early life, although it is usually less pronounced than that following coxitis. Under such circumstances the head of the bone is displaced backward and upward upon the outer surface of the ilium, where a new joint surface may occasionally be formed. The affected leg becomes considerably shortened, and accordingly an undue share of the body weight is transmitted through the well leg, which forces the corresponding side of the pelvis upward, inward, and backward, and leads to an oblique contraction, just as in coxalgia.

Unless the patient has had the benefit of proper orthopedic treatment in unilateral *infantile paralysis,* as well as in those cases in which disease at the knee or ankle joint or amputation early in life has caused shortening of one leg, similar changes occur in the pelvis, though it rarely assumes the extreme degree of obliquity which characterizes the coxalgic variety.

Diagnosis.—A limping gait at once suggests an obliquely contracted pelvis, and when, upon questioning the patient, it is found that the condition has been present since early childhood, the existence of pelvic deformity upon the side corresponding to the sound leg becomes highly probable.

More accurate information can be obtained by careful examination of the naked patient, when the posture of the involved leg is noted, as well as the relative position of the posterior superior spines and the crests of the ilia. At the same time the presence or absence of compensatory scoliosis is noted, and finally the extent of the oblique contraction can be determined by the employment of the measurements suggested by Naegele for the detection of the obliquely ovate pelvis per se. An accurate conception concerning the degree of contraction, however, can be obtained only by careful exploration of the interior of the pelvis, preferably with the patient under the influence of an anesthetic, although in many coxalgic patients this may be extremely difficult on account of the ankylosis of one leg. X-ray pictures, of course, afford valuable confirmatory information.

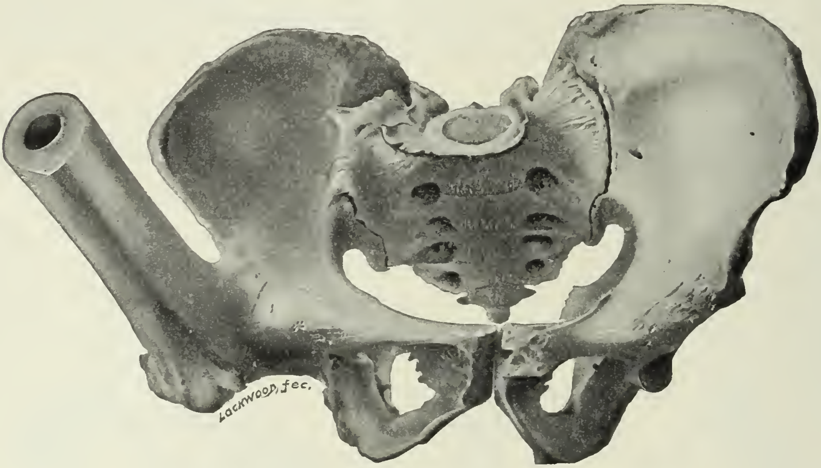

Fig. 681.

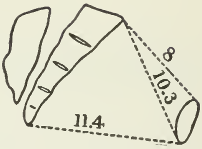

Fig. 682.

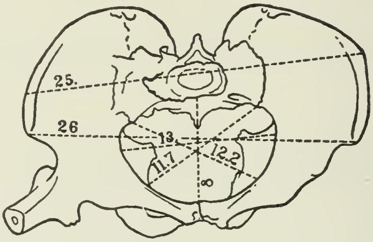

Fig. 683.

Figs. 681-683.—Coxalgic Pelvis with Ankylosed Femur.

Effect upon Labor.—The effect of this type of pelvis upon labor varies with the extent and position of the deformity. If the affected side is so contracted as to prevent its being occupied by a portion of the presenting part, we have for all practical purposes a generally contracted pelvis, and engagement, if it can occur at all, will take place more readily when the biparietal diameter of the head is in relation with the long oblique diameter of the superior strait.

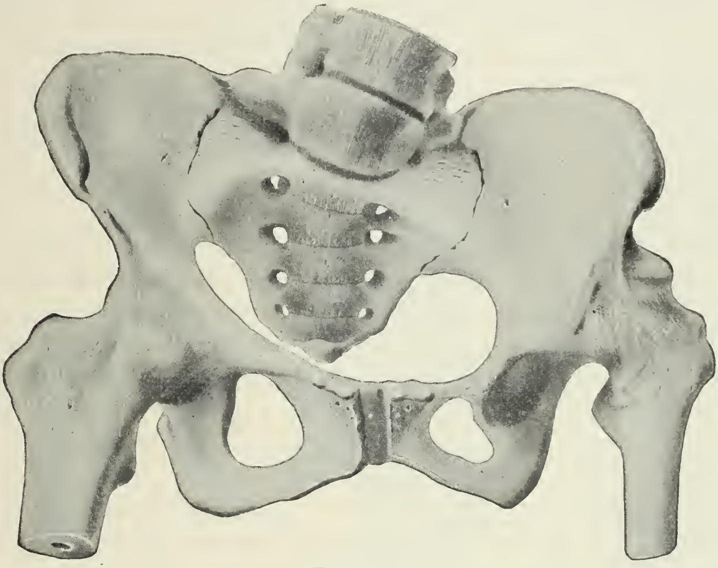

Fig. 684.

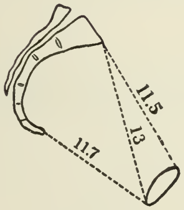

Fig. 685.

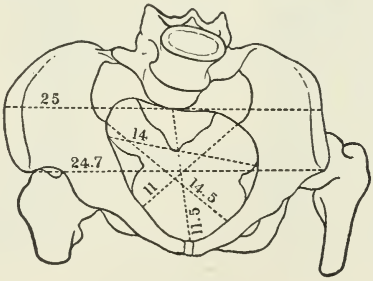

Fig. 686.

Figs. 684-686.—Obliquely Contracted Pelvis, Due to Unilateral Luxation of Femur.

But even after descent has occurred, all obstacles to labor have by no means been overcome, since in many cases the inward projection of the ischium may lead to abnormalities in rotation. Generally speaking, these pelves are not excessively contracted, Prouvost reporting that 40 out of the 50 cases of labor complicated by them ended spontaneously.

Treatment.—Although the pelvic contraction is usually not very pronounced, serious dystocia may occur. For this reason, if engagement has not occurred during the last weeks of pregnancy, the patient should be examined under anesthesia, and the entire interior of the pelvis carefully palpated. If it appears probable that engagement will not occur, cesarean section should be performed before the onset of labor. Fortunately, this is rarely indicated, unless the fœtus is unduly large, or the history of previous labors has shown that the birth of a living child is out of the question. When the obstacle to the engagement of the head is not serious, version gives better results than forceps. This is especially true in coxalgic pelves when the awkward position of the ankylosed leg, as well as the asymmetry of the pubic arch, may make the application of forceps extraordinarily difficult.

Pubiotomy is not a justifiable operation in coxalgic pelves, as we have no means of determining in advance whether the sacro-iliac synchondroses are synostosed; and if such be the case the operation cannot lead to a satisfactory increase in the capacity of the pelvic canal.

Coxarthrolisthetic Pelvis.—Very exceptionally as the result of localized softening in the region of the acetabulum, the base of one or both acetabula yields to the pressure exerted by the head of femur, and projects into the pelvic cavity, thus leading to a uni- or bilateral transverse contraction, which when pronounced may give rise to serious dystocia. Eppinger, who studied the condition exhaustively in 1903, designated such pelves as coxarthrolisthetic, and attributed their production to delayed and deficient ossification of the base of the acetabulum. The deformity was known to A. W. Otto as early as 1824, and Breus and Kolisko have shown that it is usually dependent upon gonorrheal coxitis, instead of upon arthritis deformans or tubercular processes, as was formerly believed. Chiari, however, in 1912, described a specimen which he held had resulted from tabetic arthritis. The condition is rare, and Benda has collected cases reported up to 1926 and has critically considered their mode of production.

PELVIC DEFORMITY DUE TO BILATERAL LAMENESS

Occasionally children are born with *luxation of both femora,* the heads of the bones lying, as a rule, upon the outer surfaces of the iliac bones, above and posterior to their usual situation. In some cases the acetabula are entirely absent, but more frequently they are present in a rudimentary condition, new but imperfect substitutes being formed higher up. Strange to say, the condition does not usually seriously interfere with the individual in the matter of learning to walk at the usual age, though the gait is more or less wabbly.

The pelvic changes resulting from this condition have been studied particularly by Kleinwächter, Schauta, and Sassmann, the last writer having collected 27 cases from the literature. Owing to the fact that the upward and inward force exerted by the femora is not applied in its usual direction through the acetabula, the pelvis becomes unduly wide, and more or less flattened antero-posteriorly. The transverse widening is particularly marked at the inferior strait, while the flattening, as a rule, is not very pronounced. Indeed, Delmas, after studying 17 cases, concludes that the various diameters are usually enlarged unless the condition is complicated by some other abnormality. Hence, this pelvis rarely offers any serious obstacle to labor.

Verning, in 1928, directed attention to the fact when the patient is placed in the obstetrical position that the heads of the femora may slip through the sacrosciatic notches and so encroach upon the pelvic cavity as to cause dystocia. Fortunately, this accident should not lead to serious trouble, as experience teaches that a change in the position of the legs effects reduction of the luxation.

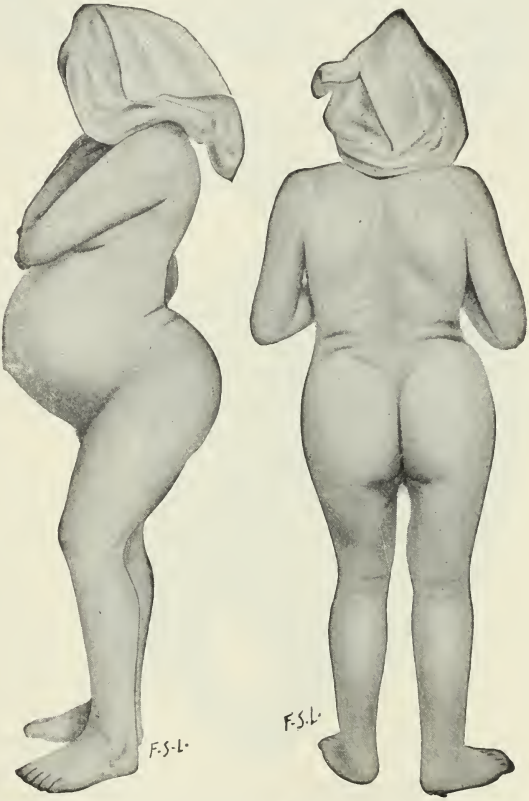

Fig. 687.—Side and Rear View of Patient with Bilateral Luxation of Femora.

The patient presents a characteristic appearance, which is suggestive of that observed in spondylolisthesis. Owing to the displacement of the femora the trochanters are more prominent than usual, and the width of the buttocks is increased. At the same time, owing to the increase in the pelvic inclination, there is marked lordosis, the back of the patient appearing considerably shortened and presenting a marked saddle-shaped depression just above the sacrum.

Meyer described a pelvis obtained from an individual who had *double clubfoot,* and found that it was markedly funnel-shaped. This condition he attributed to the absence of the usual spring at the foot and ankle joints, and to the fact that the knees were held fixed during walking. Accordingly, with each step a distinct shock was imparted to the acetabula, instead of the more gentle force which is exerted under ordinary circumstances.

In 1927, I observed a peculiar case, in which as the result of the complete absence of the heads of both femora, it was impossible to flex or abduct the legs. When I first saw the patient, it appeared that cesarean section would probably be necessary to effect delivery, but she fell into labor unexpectedly and had a rapid and spontaneous labor. Peabody has reported a similar case.

ATYPICAL DEFORMITIES OF THE PELVIS

In rare instances the pelvis may be more or less deformed by the presence of bony outgrowths at various points, and less frequently by tumor formations. *Exostoses* are most frequently observed upon the posterior surface of the symphysis, in front of the sacro-iliac joints, or upon the anterior surface of the sacrum, though in occasional cases they may be formed along the course of the iliopectineal line.

Kilian, in 1854, directed attention to the fact that such structures may form sharp, more or less knifelike projections. He designated the condition as *acanthopelys* or *pelvis spinosa.* Such formations are rarely sufficiently large to offer any obstacle to labor, but owing to their peculiar structure may do considerable injury to the maternal soft parts. In fact, in several of the cases reported, they have cut through the lower portions of the uterus.

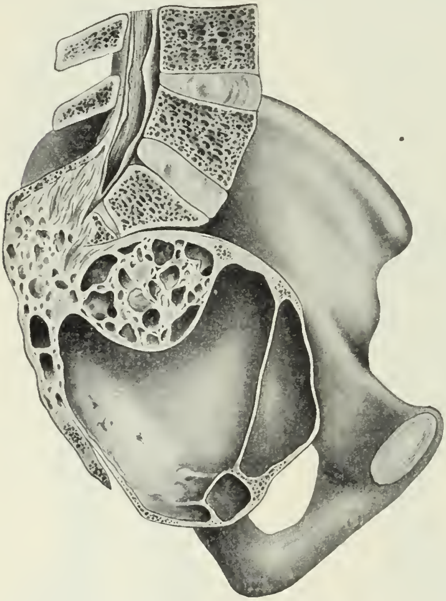

Fig. 688.—Obstruction of Pelvic Canal by Cystic Enchondroma (Schopping).

Rarely, *callous formation,* resulting from inflammatory processes within the pelvis, may attain such proportions as to lead to serious pelvic obstruction, as in a case reported by Ahlfeld.

Tumor formations of various kinds may spring from the walls of the false or true pelvis, and so obstruct its cavity as to render labor impossible. Fibromata, osteomata, enchondromata, carcinomata, and osteosarcomata of the pelvis have been described, and sometimes assume very considerable proportions, and occasionally become cystic. Stadfeld was able to collect 49 such cases in 1879, and Goder 81 cases in 1895. Enchondromata occur more frequently than other varieties of tumor formation, Schopping being able, in 1907, to collect 33 well-described cases from the literature. He pointed out that such tumors grow especially rapidly during pregnancy and give rise to serious dystocia; 21 cesarean sections and 3 destructive operations being necessary in his series of cases.

Unless cesarean section is performed, the prognosis is very grave when the pelvis is obstructed by tumors from its walls, 50 per cent of the mothers and 89 per cent of the children having perished in the cases collected by Stadfeld, while in only 11 cases was labor terminated by spontaneous delivery, forceps, or version.

Occasionally, healed *fractures* of the pelvis may offer an insuperable obstacle to the birth of the child, owing either to an excessive formation of callus or to the projection of the broken ends of the bones into the pelvic cavity. This condition, however, is very rare, it being stated that only 0.8 per cent of all fractures involve the pelvis, and in such cases the internal injuries are usually so severe as to lead to the death of the patient, so that only a small proportion of such women survive to become pregnant.

The effect upon labor depends upon the location of the fracture and its manner of healing. Figure 689 shows a pelvis described by Mars, and gives an idea of the extent of the changes which sometimes result. In a case reported by Neugebauer, in which there was a transverse fracture of the second sacral vertebra, the vertebral column prolapsed into the pelvic cavity and gave rise to a deformity suggestive of spondylolisthesis. For further details the reader is referred to the articles of Schauta, Tarnier, Meurers, and Breus and Kolisko.

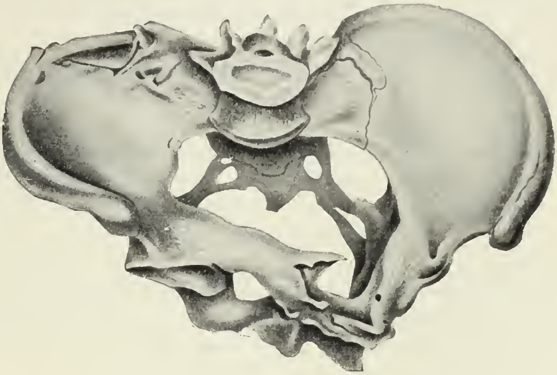

Fig. 689.—Fractured Pelvis (Mars).

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CHAPTER XXXIX

DYSTOCIA DUE TO ABNORMALITIES IN DEVELOPMENT OR PRESENTATION OF THE FŒTUS

EXCESSIVE DEVELOPMENT

As stated in Chapter V, the child at birth rarely exceeds 11 pounds (5000 grams) in weight, though authentic accounts of much larger infants are to be found in the literature.

Provided the pelvis is not contracted, it is very exceptional for a normally formed child, weighing less than 10 pounds (4500 grams), to give rise to dystocia by its mere size. In overdeveloped children the difficulty is generally due to the fact that the head tends to become not only larger but harder, and consequently less malleable with increasing weight; although it sometimes happens that after the head has passed through the pelvic canal without difficulty the dystocia may be due to the arrest of the unusually large shoulders either at the pelvic brim or outlet.

Excessive development of the fœtus can usually be traced to one of four causes: prolongation of pregnancy, large size of one or both parents, advancing age, or multiparity of the mother.

Cases in which three hundred days or more elapse between the last menstrual period and the onset of labor are not uncommon, and, in the case of Gaskill versus Gaskill, the English Courts, in 1921, after hearing competent expert testimony, decided that a child was legitimate which had been born 331 days after the last coitus. Oyamada states that the possibility of prolonged pregnancy was present in 11 per cent of 932 children born in the Munich clinic between the years 1885 and 1910; namely, whose weight exceeded 9 pounds (4000 grams) and labor did not set in until four or more weeks after the calculated date.

In the majority of cases of supposed prolongation, the delay is only apparent, and is dependent upon the forgetfulness of the patient concerning the date of the last menstruation. In this event, the size of the child does not greatly exceed the average. On the other hand, actual prolongation occasionally occurs, and I can recall several cases in which eleven lunar months had elapsed between the last menstrual period and the birth of an excessively large child. In such circumstances serious dystocia may arise, inasmuch as the child may increase in size for each day beyond full term that it remains in the uterus. Accordingly, whenever labor fails to occur within a few days of the calculated date, the patient should be carefully examined at least once each week, and labor induced as soon as one is convinced that the child is postmature.

More frequently the excessive size of the child is due to the fact that one or both of its parents are unusually large; moreover, it is a matter of common observation that the fœtal head in many instances resembles that of its father, large-headed men usually producing children with similar characteristics. Likewise the age of the mother may have an important influence upon the fœtal development. Thus, the children of elderly primiparæ frequently exceed the usual average, and in multiparæ the children are often larger with each successive pregnancy, provided they do not follow in too rapid succession.

As a rule, large children have well ossified skulls. This is more particularly true for males, in whom the biparietal diameter is usually somewhat greater than in female children of the same weight. In such cases the inability of the head to become molded not only interferes with its engagement, but predisposes to such injuries as spoon-shaped depressions of the skull.

Although, in the case of a normal pelvis, a moderate increase in the size of the child is usually without practical significance, when any degree of contraction exists such a condition may make all the difference between an easy and a very difficult labor. At the same time, in multiparous women the dystocia is often due in great part to the loss of tone of the uterine musculature incident to repeated childbearing. On the other hand, it should always be remembered that quite as serious dystocia may arise when an excessively large head attempts to pass through a normal pelvis, as when a head of average size is arrested by a definitely contracted superior strait.

Inasmuch as our means of determining the size of the child, and particularly of its head, are far from accurate, the diagnosis of excessive development is, as a rule, not established until after fruitless attempts at delivery have been made. Nevertheless thorough examination, in which careful palpation and Müller's method of impression are employed, should ordinarily enable the trained obstetrician to arrive at fairly accurate conclusions and prepare him to meet this complication. If the pelvis is normal the failure of engagement in the last weeks of pregnancy in a primipara, or the existence of a face, brow, or transverse presentation, should suggest the possibility of excessive size of the child.

Treatment.—If the patient has apparently gone beyond term, and examination shows that the size of the child is above the average, there should be no hesitancy in the immediate induction of labor as a prophylactic measure. On the other hand, if the child is small, induction should not be thought of. In multiparous women with normal pelves whose history shows that excessive fœtal development was the cause of the previous difficult labors, the size of the child may occasionally be regulated by restricting the use of carbohydrates during the last two months of pregnancy. If this does not have the desired result, labor should be induced as soon as the child has attained a normal size.

On the other hand, if the calculated date of delivery is not delayed, the excessive size of the child is rarely suspected by the ordinary practitioner before the onset of labor, and the diagnosis is made only after Nature has shown that she is unable to effect delivery. It is, however, exactly in this type of case that the benefits of efficient prenatal care become manifest. If the patient is carefully palpated at intervals during the last months of pregnancy, and weekly if the child is not born within one week following the caluculated date of delivery, excessive size of the child will rarely escape recognition. In several instances, I have done cesarean section solely on that account, and each month I induce labor when the child has attained somewhat more than the average size, because I feel that it is irrational to allow it to grow sufficiently large to cause actual dystocia.

Zangemeister and Lehn, in 1918, studied the obstetrical significance of excessively large children, and, while they found that ordinarily a weight less than 4500 grams (10 pounds) does not give rise to dystocia, they stated that the chances of the child being born alive decrease progressively with each additional 500 grams. Accordingly, prophylactic treatment is the ideal in these, as well as in so many other obstetrical circumstances. If, however, the complication has not been recognized until the patient is well advanced in labor, it is often difficult to determine the best method of procedure. If examination shows that the head is not engaged and that the disproportion is excessive, the propriety of low cervical cesarean section should be considered, provided that unavailing attempts at delivery have not been made. On the other hand, if physicians with questionable technic have failed to effect delivery by forceps or version, radical surgical interference is contra-indicated, and craniotomy becomes our sole resource.

When excessive size of the shoulders prevents the delivery of the child after birth of the head, labor can often readily be terminated after diminishing the size of the shoulder girdle by cutting through the clavicles with a pair of heavy scissors—*cleidotomy.*

MALFORMATIONS OF THE FŒTUS

Double Monsters.—For practical purposes three groups of double monsters may be distinguished: (1) Incomplete double formations at the upper or lower half of the body (diprosopus, dipagus); (2) twins which are united together at the upper or lower end of the body (craniopagus, ischiopagus, or pygopagus); (3) double monsters which are united by the trunk (thoracopagus and dicephalus).

The diagnosis of any one of these conditions is rarely made until difficulty experienced in attempting delivery has led to careful exploration under anesthesia with the entire hand *in utero,* although the existence of a multiple pregnancy may have been suspected. As such monstrosities frequently present minor deformities as well, the detection of a clubfoot, harelip, etc., should direct one's attention to the possible existence of some still more serious abnormality.

Fortunately the delivery of many monstrosities is sometimes much more readily accomplished than would appear possible at first sight. In the first place, such pregnancies rarely go on to full term, so that the monstrosity may not exceed a normal child in size. In the second place, the connection between the two halves is often of such a character as to permit of sufficient motility between the component parts as will make their successive delivery possible.

On the other hand, in the first group the large size of the doubled portion of the monster may lead to serious mechanical obstacles. The fused head in a *diprosopus* is, as a rule, much more readily delivered when it forms the after-coming part than when it presents primarily. In the second group a *craniopagus* presenting by the head usually causes only a moderate amount of difficulty; whereas *ischiopagi* and *pygopagi,* as a rule, call for complicated and difficult maneuvers before delivery can be effected.

In the third group, the delivery of *dicephalic monsters* is facilitated when they present by the breech, as in many cases first one and then the other head can be extracted. On the other hand, in cephalic presentations the two heads may mutually interfere with each other and thus prevent engagement until one has been diminished in size by craniotomy. When engagement of one head occurs delivery can be partially effected by forceps, but as a rule the head cannot be delivered beyond the pubic arch for the reason that further descent is prevented by the arrest of the second head at the superior strait. Under such circumstances it is advisable to amputate the first head, after which delivery of the rest of the monster is, as a rule, best accomplished by version.

Thoracopagi usually offer a less serious obstacle to delivery, for the reason that they are frequently so loosely connected with one another that considerable motility is possible. Indeed, it is not unusual for the two children to present in a different manner. When possible, it is advisable to bring down all four feet at the same time, and to effect extraction in such a way that the posterior head is first delivered. In cephalic presentations the head and the body of the first child are expelled, and the second child is then born very much as in an ordinary twin pregnancy. If, however, the latter presents transversely, its delivery can be effected only by version and extraction.

DEFORMITIES OF FŒTUS

In this place attention will be directed only to those abnormalities in fœtal development which may give rise to difficult labor. An *acardiacus* is a monster which is sometimes developed in single-ovum twin pregnancies as the result of inequalities in the communicating placental circulation. One twin is well developed and normal, while the other is imperfectly formed, and either possesses a rudimentary heart or no heart at all, being designated according to Kehrer as hemiacardius or holoacardius, respectively. The genesis of such conditions was considered in the chapter on Multiple Pregnancy.

The holoacardiac monsters may occur as acephali, amorphi, or acormi. Of these the most common variety is the *acephalicus* or headless fœtus. Less common is the *amorphous* monster, which possesses neither a head nor extremities, but is round in shape and presents upon its surface a number of small nodules, which represent the rudimentary extremities. The umbilical cord may be attached to any portion of its surface. The interior of the monstrosity contains a rudimentary intestinal tract, cystic cavities, vertebræ, etc., but no trace of a heart. The rarest variety of acardiacus is the *acormus* or trunkless monster, which consists of an imperfectly developed head and a rudimentary body, the umbilical cord being attached to the cervical region.

As a rule, such monsters do not attain any notable size, although exceptionally, as the result of obstruction in the umbilical vein, they may become edematous and give rise to dystocia.

The *anencephalus* or *hemicephalus* is a monster possessing a trunk, but only an imperfectly developed head, from which a large part of the brain and skull is lacking. Ordinarily such beings are of moderate size, but occasionally the shoulders may be so excessively developed as to give rise to serious dystocia.

Since the time of Morgagni it has been known that over three-quarters of such monsters are females, and it is generally stated that the adrenals are lacking. Kratsch, however, found them in all of the 17 specimens which he studied, but much smaller than usual, particularly in the cortical portion.

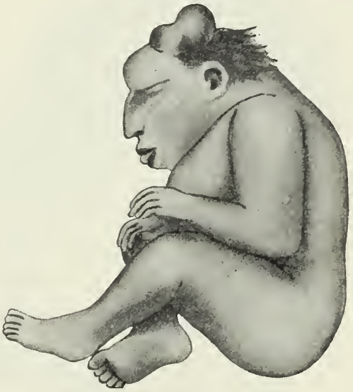


FIG. 690.—ANENCEPHALUS.

Owing to the absence of the cranial vault the face is very prominent and somewhat extended, the eyes often protrude markedly from their sockets, and the tongue hangs from the mouth. The brain is in a rudimentary condition, and the base of the skull is accessible to the examining finger, so that the sella turcica can be distinguished. Owing to the exposed condition of the base of the brain and the upper part of the medulla, there is frequently a marked increase in the amount of amniotic fluid, its production being analogous to that noted in the piqûre experiments of the physiologists.

In view of the abnormal shape of the head, face presentations are frequently observed, while those of the vertex are less common than with a normal fœtus. Transverse and foot presentations are likewise not unusual.

When the monstrosity presents by the face or head a correct diagnosis is frequently made by vaginal touch, the characteristic bulging of the eyes being noted in the former, and the absence of the cranial vault and the presence of the sella turcica in the latter presentation. As the deformity is frequently accompanied by hydramnios, the occurrence of that condition should arouse suspicion as to the possibility of fœtal abnormalities. In such cases, x-ray examination frequently leads to the recognition of anencephalic, hydrocephalic or dicephalic children, as reported by Falls, Nölli and others.

Delivery, as a rule, occurs much more readily when the monster presents by the breech, for the reason that the imperfectly developed head is not an efficient dilating agent, though in many cases rapid and spontaneous delivery is observed. Even when the enlarged shoulders give rise to dystocia, delivery can usually be accomplished by means of version without any great difficulty.

HYDROCEPHALUS

In this not very rare condition, the cerebral ventricles are distended by an excessive amount of cerebrospinal fluid (Fig. 691), which, according to the researches of Dandy and Blackfan, is due to the obliteration of Magendie's foramen. As a result the head becomes much increased in size, frequently attaining several times its normal dimensions, while the brain substance forms a layer only a few millimeters thick beneath the skull, but occasionally it has entirely disappeared, except for a few tags of tissue in the neighborhood of the central ganglia. At the same time the cranial bones are imperfectly developed, the sutures and fontanels being much wider than usual.

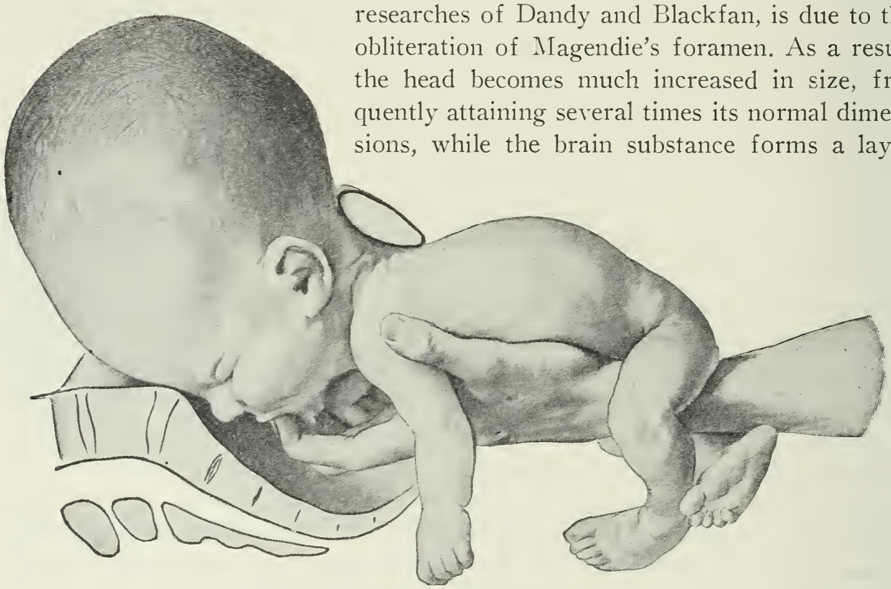


Fig. 691.—Dystocia Due to Hydrocephalus (Bumm).

If the enlarged head is not tensely filled with fluid, under the influence of the uterine contractions it may undergo such changes in shape that its spontaneous expulsion becomes possible. This, however, is so rare a possibility that it should not be reckoned with in determining the treatment to be pursued in a given case. Still less frequently, owing to the pressure to which the head is subjected at the time of labor, the tissues forming a fontanel or suture may give way, so that the cerebrospinal fluid can escape, after which the head collapses and spontaneous delivery becomes possible. In the vast majority of cases, however, the condition gives rise to serious dystocia, which if not promptly relieved will lead to rupture of the uterus and the death of the patient from intra-abdominal hemorrhage.

In hydrocephalic children, although cephalic presentations predominate, owing to the lack of accommodation between the head and the pelvic canal, the breech is often substituted.

Diagnosis.—As a rule the condition is not recognized until several hours of fruitless second-stage pains have demonstrated the existence of an obstacle to delivery. On the other hand, careful examination should ordinarily lead to correct diagnosis during the last weeks of pregnancy or soon after the onset of labor. In many cases the deformity can be detected by external palpation, the immensely large and movable head being isolated above the superior strait or in the fundus of the uterus. Furthermore, the examiner should always be on the lookout for the presence of fluctuation, while a peculiar crackling sensation can be elicited by pressure upon the skull. I have made a positive diagnosis in this manner upon several occasions without an internal examination.

As soon as the cervix is dilated, vaginal examination will reveal a large head with widely gaping sutures, through which fluctuation can be obtained by appropriate maneuvers. Naturally this does not hold good in breech presentations, but here abdominal palpation will reveal the presence of the large fluctuant head in the fundus of the uterus, or just above the superior strait, in case attempts at extraction have been made.

Prognosis.—For the child the outlook is uniformly bad, for even if born alive it usually succumbs within a few days, or, in the rare cases in which it survives, grows up a hopeless idiot. The maternal prognosis depends largely upon the obstetrician. If left to Nature the usual termination is rupture of the uterus; whereas, if the condition be detected and the proper treatment instituted, the results are almost universally favorable.

Treatment.—As soon as the cervix has become completely dilated the head should be perforated through one of the wide sutures, in order that the cerebrospinal fluid can escape and the skull collapse, after which delivery can be effected by the unaided efforts of Nature, or may be accelerated by the employment of the cranioclast. In breech presentations, when the head has been arrested at the superior strait, evacuation of its contents can be readily effected by excising the arch of one of the cervical vertebræ and passing a catheter through the vertebral canal. On account of the nature of the disease and its effect upon the child, craniotomy may be undertaken without hesitancy, even by those who ordinarily do not consider it a justifiable procedure.

In evacuating the hydrocephalic head, it should be borne in mind that, owing to the extreme thinness of the brain, mere perforation is not necessarily synonymous with fœtal death. For this reason the perforator should be carried to the base of the skull and vigorously manipulated in order to destroy the medulla, as nothing could be more horrible than the extraction of a living child after such an operation.

ENLARGEMENT OF THE BODY OF THE FŒTUS

Enlargement of the abdomen sufficient to cause grave dystocia is usually the result of ascites, a very much distended bladder, or of tumors of the kidneys or liver.

Whenever the abdominal distention is excessive spontaneous labor is out of the question; but unfortunately the condition usually escapes detection until fruitless attempts at delivery have demonstrated the existence of some obstruction and have led the obstetrician to introduce his entire hand into the uterus in the hope of discovering its nature.

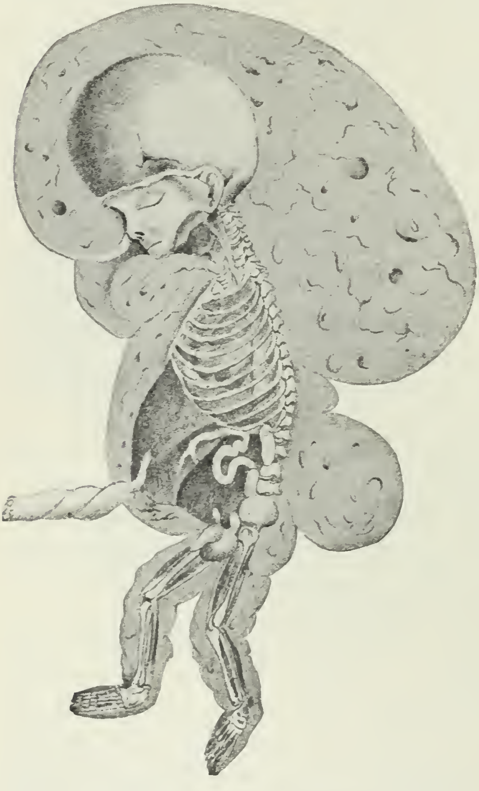


FIG. 692.—ELEPHANTIASIS CONGENITA CYSTICA (Ballantyne).

Occasionally a fœtus affected with *general dropsy* may attain such immense proportions that spontaneous delivery is impossible. A number of such cases are recorded in the monographs of Ballantyne, Schumann, and Dorland. In very rare instances the ascites associated with *fœtal peritonitis* may have a similar result, and exceptionally a child suffering from *chondrodystrophia fœtalis* may become so edematous as to give rise to dystocia.

As the result of the dilatation of the superficial lymphatics associated with edema of the subcutaneous tissues, the fœtus may assume immense proportions and take on a bizarre shape. This condition, which is designated as *elephantiasis congenita cystica,* has been studied in detail by Ballantyne, and is a very rare cause of difficult labor (Fig. 692).

Defective development of the lower portion of the urinary tract may lead to the *retention of urine* accompanied by distention of the abdomen sufficient to render normal delivery impossible (Fig. 693). Examples of this condition have been reported by Walther, Schwyzer, and others, who also give details as to its etiology.

A more frequent cause of abdominal enlargement is the presence of *congenital cystic kidneys.* The growth, which is histologically an adenocystoma, may involve one or both organs, and give rise to tumors of immense size. The condition is frequently associated with dilatation of the ureters, and with dropsical effusions into the various body cavities. Figure 694 gives an idea of the extent of the abdominal enlargement in a child which I delivered, and which was described by Lynch, in 1906, together with an analysis of 50 other cases reported in the literature.

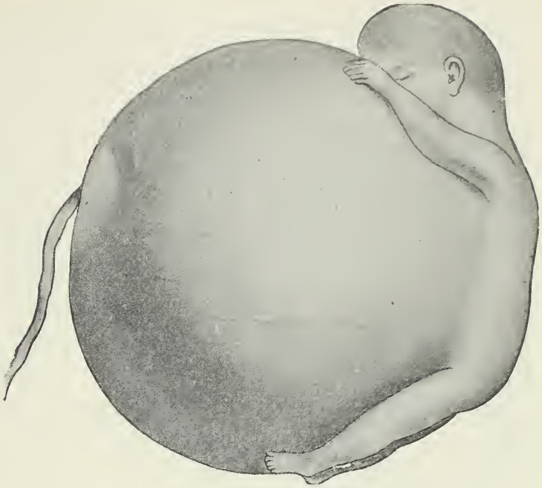


Fig. 693.—Fœtus with Immensely Distended Bladder (Hecker).

In rare cases the abdominal enlargement may be due to *tumors of the liver,* Porak and Couvelaire having reported a case of congenital cystic liver associated with a similar condition of the kidneys. Moreover, large tumors, arising from any of the abdominal organs, may give rise to dystocia. Thus, Rogers has described an immense *fibrocystic testicle,* and Phaenomenow an aortic aneurysm so large as to interfere with delivery. In rare instances fœtal inclusions, such as the so-called *fœtus in fœtu,* may be responsible. Occasionally the invasion by Bacillus aërogenes capsulatus may be followed by such an extensive production of gas that the size of the fœtus becomes more than doubled, when spontaneous delivery is impossible.

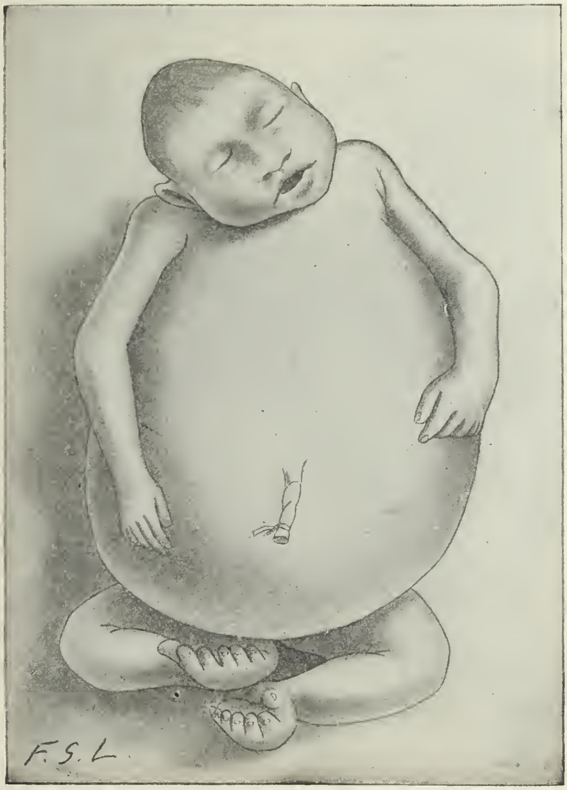


Fig. 694.—Fœtus with Congenital Cystic Kidneys.

In all of these conditions, if the dystocia is marked, delivery can be accomplished only after opening the body of the fœtus and allowing the fluid to escape, or by removing a portion, at least, of the offending tumor formation. The latter operation is not always easy, for, owing to the constrained position of the hand *in utero* and the dense consistency of the growth in many cases, great difficulty may be experienced.

In rare instances abnormal growths arising from various portions of the body of the fœtus may interfere with delivery. Cases are on record in which lipomata, carcinomata, angiomata, and various other tumors have given rise to such an enlargement that spontaneous delivery became out of the question. Exceptionally, dermoid cysts and teratomatous tumors about the perineum and sacrum may offer a serious obstacle. Figure 289 represents a fœtus in which an adenoma of the thyriod gland necessitated a destructive operation. In rare instances, a large umbilical hernia, a spina bifida, and other growths give rise to difficult labor.

DYSTOCIA DUE TO ABNORMAL PRESENTATIONS OF THE FŒTUS

Transverse Presentations.—In this condition the long axis of the fœtus crosses that of the mother at about a right angle. When it forms an acute angle we speak of an *oblique* presentation. The latter, however, is usually only transitory, becoming converted into a longitudinal or transverse presentation when labor supervenes.

In transverse presentations the shoulder usually occupies the superior strait, the head lying in one and the breech in the other iliac fossa. Accordingly, such a condition is commonly spoken of as a *shoulder,* less frequently as a *lateral plane,* and technically as an *acromion* presentation. The latter designation is chosen for the reason that the acromion process is one of the most characteristic features of the shoulder, the position being right or left according to the side of the mother toward which the acromion is directed. Moreover, as, in either position, the back may be directed anteriorly or posteriorly, it is customary to distinguish between the *dorso-anterior* and *dorsoposterior* varieties. The recognition

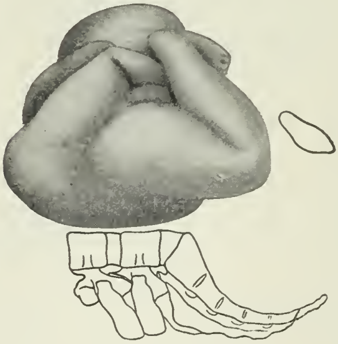


Fig. 695.—Diagram Showing Left Acromion Dorsoposterior Presentation.

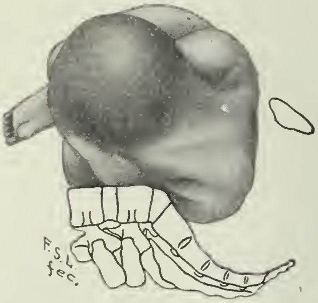
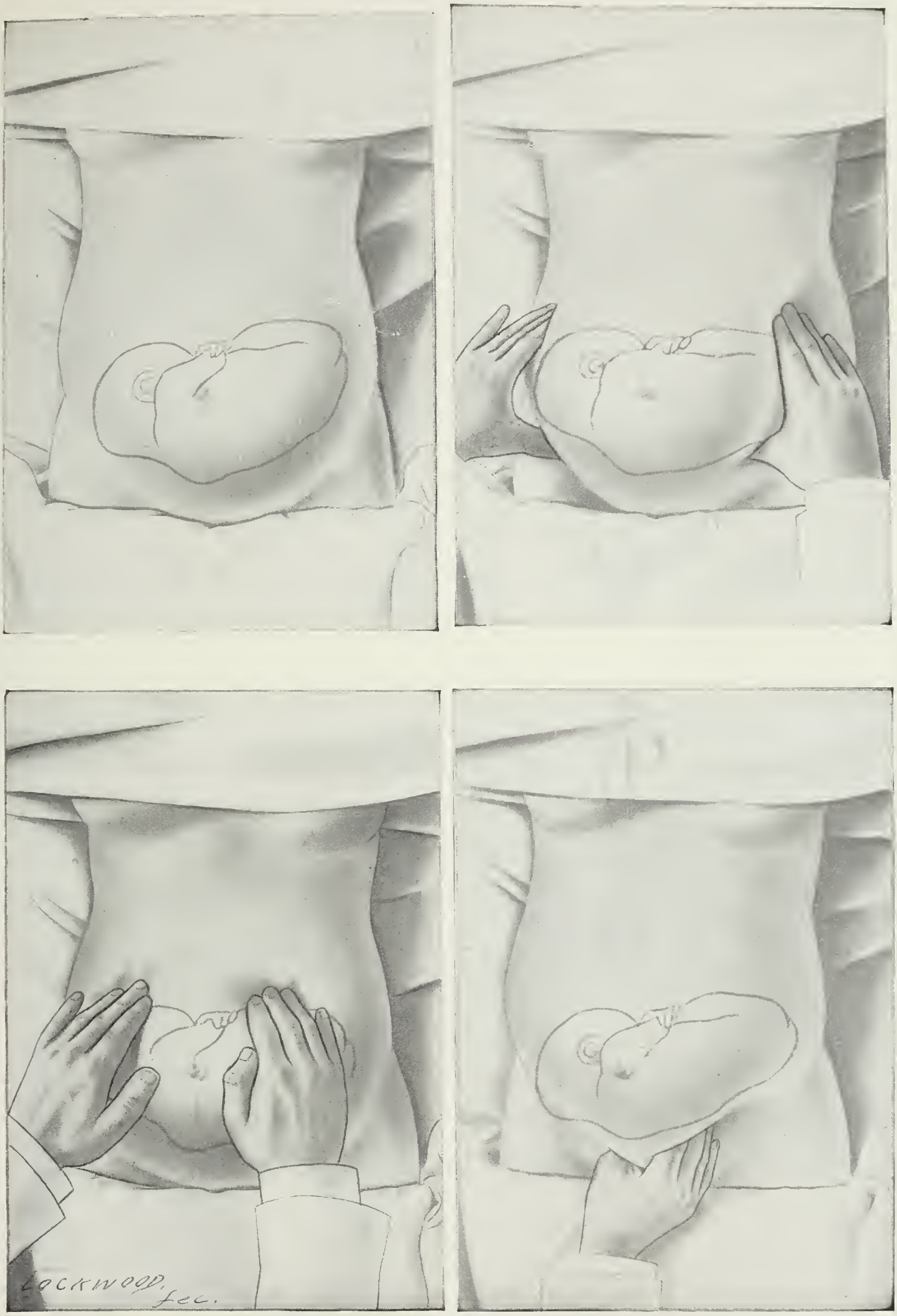


Fig. 696.—Diagram Showing Right Acromion Dorso-anterior Presentation.

PLATE XV.


LOCKWOOD, fec.

PALPATION IN RIGHT ACROMIO-DORSO-ANTERIOR PRESENTATION.

of the position of the back is of great importance in connection with the proper performance of version—the treatment *par excellence* in this condition.

According to Schroeder, the shoulder is directed toward the left side of the mother 2.6 times more frequently than toward the right, while the back looks anteriorly 2.5 times more frequently than posteriorly.

Etiology.—The existence of a transverse presentation in a primiparous woman is *prima facie* evidence of a lack of accommodation, usually the result of disproportion between the size of the head and the pelvis, though occasionally it may be due to hydramnios. In multiparæ, on the other hand, the most frequent etiological factor is abnormal relaxation of the abdominal and uterine walls, the result of repeated childbearing, which may be still further complicated by any of the causes already enumerated. Accordingly, transverse presentations are much more frequently observed in women who have borne a number of children, but in them, as a rule, the condition is less serious, for the reason that spontaneous reposition sometimes ensues after the onset of labor, the child assuming a longitudinal presentation—spontaneous version—whereas such an occurrence is very exceptional in primiparæ.

The occurrence of spontaneous version is very improbable after rupture of the membranes, and is still further hampered by any condition which interferes with the descent or engagement of the head; as, for example, a contracted pelvis, placenta prævia, a pelvic tumor, or twin pregnancy. Very exceptionally, longitudinal may become converted into secondary transverse presentations at the time of labor, and such an occurrence is always indicative of disproportion between the size of the child and the pelvis.

Diagnosis.—The diagnosis of a transverse presentation is usually readily made, inspection alone frequently causing one to suspect its existence. The abdomen is seen to be unusually wide from side to side, while the fundus of the uterus scarcely extends above the umbilicus.

On palpation the first maneuver reveals the absence of a fœtal pole from the fundus. On the second maneuver a ballottable head will be found in one and the breech in the other iliac fossa, while the third and fourth maneuvers are negative, unless labor has been in progress for some time and the shoulder has become impacted in the pelvis. At the same time the position of the back is readily determined. When it is situated anteriorly a hard resistant plane will be felt extending across the front of the abdomen; when it lies posteriorly irregular nodulations, representing the small parts, will be felt in the same location (Plate XV).

On vaginal touch in the early stages of labor, the side of the thorax readily recognizable by the "gridiron" sensation afforded by the ribs, can be made out at the superior strait. When dilatation is further advanced the scapula can be distinguished on one and the clavicle on the other side of the thorax, while the position of the axilla will indicate toward which side of the mother the shoulder is directed. Later in labor the shoulder becomes tightly wedged in the pelvic canal, and a hand and arm frequently prolapse into the vagina and through the vulva; whether it is the right or left can be readily determined by ascertaining to which one of the obstetrician's it corresponds, just as in shaking hands.

Course of Labor.—With very rare exceptions the spontaneous birth of a fully developed child is impossible in persistent transverse presentations, since expulsion cannot be effected unless both the head and trunk of the child enter the pelvis at the same time, which is manifestly impossible. Accordingly, both the fœtus and mother must almost inevitably perish if appropriate measures are not instituted. On the other hand, small premature, and particularly macerated, children are frequently born spontaneously.

Throughout the first stage, but particularly during the early period of the second stage of labor, preliminary, but futile, preparations are made for spontaneous delivery. These consist in a molding of the fœtus in anticipation of the engagement of the presenting shoulder, which results in the approximation of the head to the ventral surface of the child, by which the transverse diameter of the fœtal ovoid becomes diminished and the vertical diameter increased in length (Fig. 698). After rupture of the membranes, if the patient is left to herself, the shoulder is forced down into the pelvic cavity, and the corresponding arm frequently prolapses. After a certain amount of descent, the shoulder becomes arrested by the margins of the superior strait, with the head in one iliac fossa and the breech in the other, and with the continuance of labor becomes firmly impacted in the upper part of the pelvic cavity (Fig. 697). The uterus then contracts vigorously in the attempt to overcome the obstacle, but in vain. After a certain time the contraction ring rises higher and higher, the lower uterine segment becomes more and more stretched and eventually gives way, when a part or the whole of the product of conception escapes into the abdominal cavity. In such circumstances the patient usually succumbs within a short time

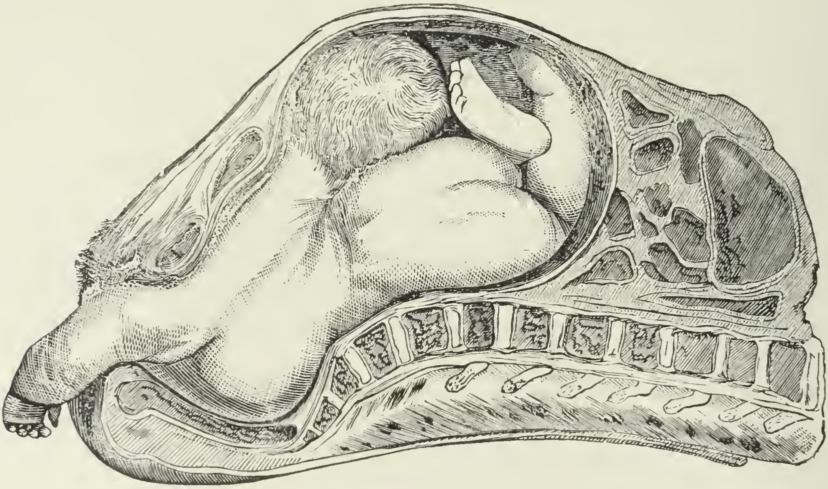


Fig. 697.—Frozen Section through Woman Dying in Labor with a Neglected Transverse Presentation (Chiara).

to intraperitoneal hemorrhage, while in other instances death from infection occurs after a longer period.

Possibly once in many thousand cases, the uterus may cease to contract before the membranes rupture, and the child, being retained within the uterus, may eventually become mummified. Such a missed labor is very rare in human beings, though it is well known to the veterinarians. On the other hand, such an occurrence would be out of the question had the amniotic sac been opened, as in such circumstances bacteria would gain access to the uterus and give rise to infection, which, if not terminating in the death of the patient, would lead to the gradual casting off of the product of conception by suppurative processes, supposing that the woman could be so long neglected.

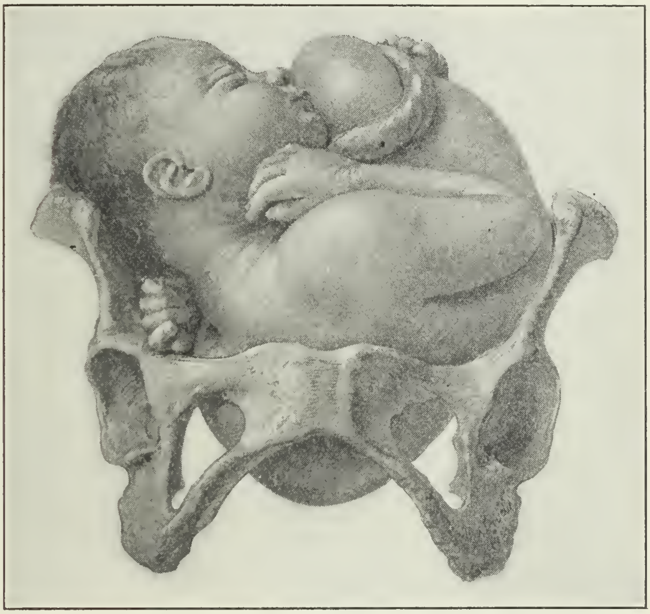


FIG. 698.—SPONTANEOUS EVOLUTION BY DOUGLAS' MECHANISM. MOULDING OF FŒTUS.

In transverse presentations, now and again, spontaneous delivery ensues. Bartholin, in the seventeenth century, pointed out that a child that has lain transversely during the later months of pregnancy may spontaneously assume a longitudinal presentation at the time of labor. This so-called *spontaneous version* is not an infrequent occurrence. Its mode of production has already been referred to.

A century later Roederer pointed out that in rare instances, if the child be very small and the pelvis large, spontaneous delivery may occasionally be accomplished in spite of the persistence of the abnormal presentation. In such cases the child becomes compressed upon itself with the head tightly pressed against the abdomen, so that a portion of the thoracic wall below the shoulder becomes the most dependent part and appears at the vulva. The head and thorax then pass through the pelvic cavity at the same time, and the child, which is doubled upon itself, is expelled—*conduplicato corpore*. Manifestly, such a mechanism is possible only in the case of very small children, and is occasionally observed when the second child in a twin pregnancy is prematurely born.

In very rare instances, a dead child of moderate or average size may be expelled spontaneously by another mechanism, which is designated as *spontaneous evolution*. This, however, is met with so rarely, demands such peculiar conditions, and is attended by such risks to the mother that its occurrence should never be counted upon in actual practice, although very occasionally in neglected cases it may occur unexpectedly and even rapidly. Several cases have been observed in my service, two of which are described in Stephenson's article, and in one of them a 2700 gram child was born eight hours after the onset of labor.

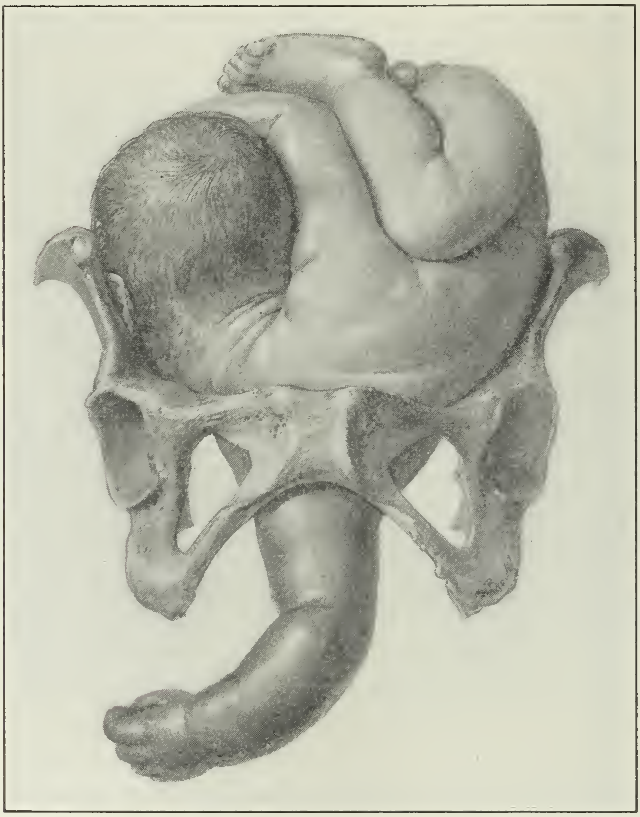


Fig. 699.—Spontaneous Evolution by Douglas' Mechanism. Prolapse of Arm and Elongation of Neck. × ⅓.

Delivery by spontaneous evolution occurs once in every several hundred transverse presentations. It was first mentioned by Denman, in 1772, and its mechanism was accurately described by Douglas, in 1811. Since then a considerable literature has accumulated upon the subject, and the articles of Payer, Zangemeister, Franz, and Stephenson deserve particular mention. It is generally stated that spontaneous evolution may be effected by either of two mechanisms,—that of Denman or Douglas. Although, after careful study of the original articles, when I helped in the preparation of Stephenson's paper, I concluded that only the latter occurs, and that the belief in the possibility of the former is based upon imperfect understanding of Denman's casual and imperfect description of the process.

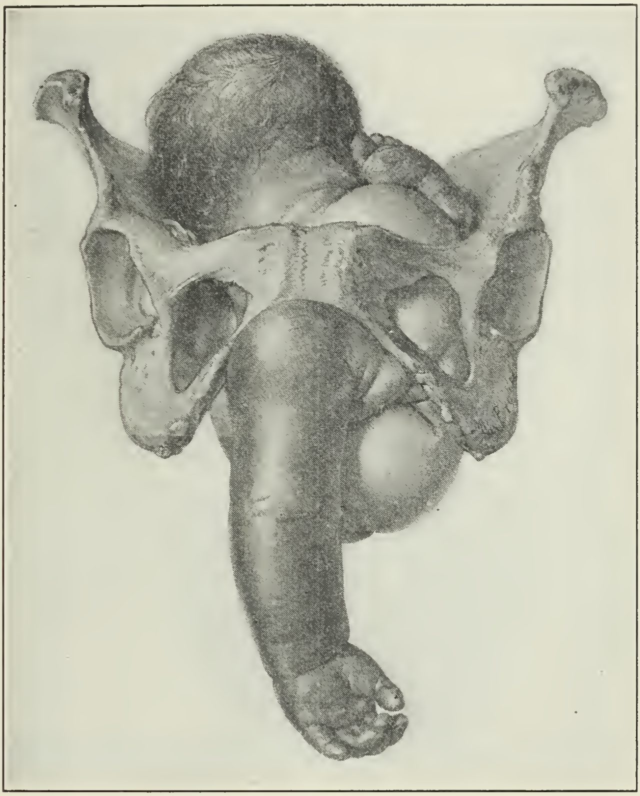


Fig. 700.—Spontaneous Evolution by Douglas' Mechanism. Birth of Anterior Shoulder and of Buttocks. × ⅓.

In Douglas' mechanism, the first stage consists in the molding of the fœtus and impaction of the shoulder with prolapse of the arm, as described in a preceding paragraph. Then, under the influence of strong uterine contractions, the child rotates about its vertical axis, so that one side of the head comes to lie over the horizontal ramus of the pubis with the breech in the region of the opposite sacro-iliac joint, while the neck subtends the inner surface of the symphysis pubis (Fig. 699). Coincident with excessive stretching of the neck, the prolapsed arm continues to descend until eventually the corresponding shoulder emerges under the pubic arch. The escape of the arm and shoulder affords room for the entrance of the rest of the body of the child into the pelvic cavity, and the lower side of the thorax, promptly followed by the breech, soon emerges from the vulva. Following the breech the anterior side of the thorax and the remaining arm are delivered, and finally the head is born spontaneously, or is extracted manually, according to the exigencies of the case (Fig. 701).

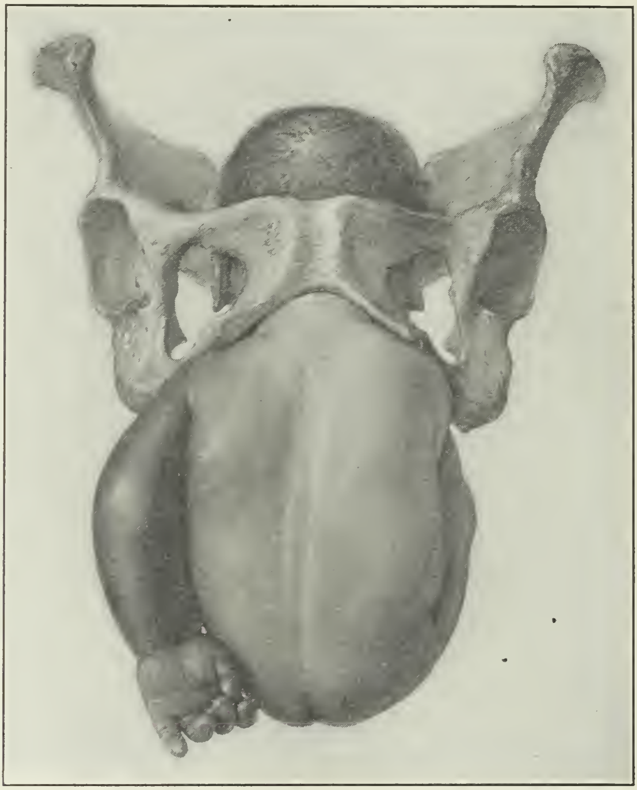


Fig. 701.—Spontaneous Evolution by Douglas' Mechanism. Birth of Body. × ⅓.

In such cases the prolapsed arm is immensely swollen and a *"caput succedaneum"* develops over the presenting shoulder. From our studies it would appear that spontaneous evolution is possible only when the child is not unduly large and in the presence of strong uterine contractions and an unusually elastic neck. Herrgott has reported an instance in which the child weighed 3300 grams, and has collected the French literature upon the subject up to 1918. Delivery by

Douglas' mechanism would probably have been effected in Chiari's case had the patient survived.

Prognosis.—If spontaneous version does not occur within the first few hours after the onset of labor, and operative procedures are not instituted, spontaneous evolution offers the only possibility for spontaneous delivery; and as this occurs so rarely as to be negligible, the outcome for both mother and child is almost uniformly fatal, the child succumbing to asphyxia and the mother to hemorrhage or infection, as a result of rupture of the uterus. On the other hand, if appropriate measures are instituted, the prognosis for the child is fair, while for the mother it is excellent. In this class of cases prolapse of the cord is one of the most frequent causes of fœtal death.

Treatment.—If the diagnosis has been made in the last month of pregnancy and no serious disproportion is present, cephalic version should be effected by external manipulations, and the child held in its new position by means of a properly fitting bandage. On the other hand, if the pelvis is much contracted, such a procedure is useless, as cesarean section at an appointed time will be the operation of choice.

If the patient is not seen until after labor has set in external cephalic version should likewise be attempted, provided the membranes have not ruptured. As a matter of fact, however, such manipulations will usually prove unsuccessful. In this event one should wait until the cervix is almost completely dilated and then, after rupturing the membranes, perform internal podalic version, followed by prompt extraction.

On the other hand, if the patient be not seen until she is well advanced in labor and the membranes have ruptured, the treatment will vary according to the degree of dilatation of the cervix, the condition of the patient, the degree of impaction of the shoulder, and the condition of the lower uterine segment. If the cervix is only partially dilated, while the child is alive and freely movable in the uterus, bipolar version may be attempted. After a foot has been brought down the cervix should be allowed to dilate still further before extraction is completed. On the other hand, if the condition is complicated by prolapse of the pulsating cord, the dilatation of the partially dilated cervix should be completed manually, and the child promptly extracted after internal podalic version.

Whenever the cervix is fully dilated, internal podalic version should be performed at once, according to the rules already given, and followed by immediate extraction, provided the uterus is not so tightly contracted down over the child and the lower uterine segment so thinned out that such a procedure appears synonymous with rupture. Even in such cases anesthesia sometimes so relaxes the organ that version may be safely effected, although at first glance it had appeared to be out of the question.

When the shoulder has become firmly impacted, and version appears to be contra-indicated, *decapitation* is the operation of choice, even if the child is alive; although very exceptionally cesarean section might be thought of. As such a condition is met with only in patients who have been neglected by ignorant, and probably dirty, attendants, the danger of infection is so great that classical cesarean section should not be considered. Consequently, if radical interference seems advisable, the body of the uterus should be amputated. For this reason, the procedure should be limited to multiparous women; as in the case of primiparæ it does not seem justifiable to destroy all future hope of childbearing for the sake of a child whose chances are already compromised.

The treatment of transverse presentations again affords an admirable illustration of the advantages of efficient prenatal and intranatal care. If the condition is recognized before or soon after the onset of labor, and intelligent medical care is available, the results for both mother and child are ideal; whereas if the patient is not seen until late in labor the mother is exposed to considerable risk and the child will almost inevitably be lost; finally, if medical aid is not available, both mother and child will be lost.

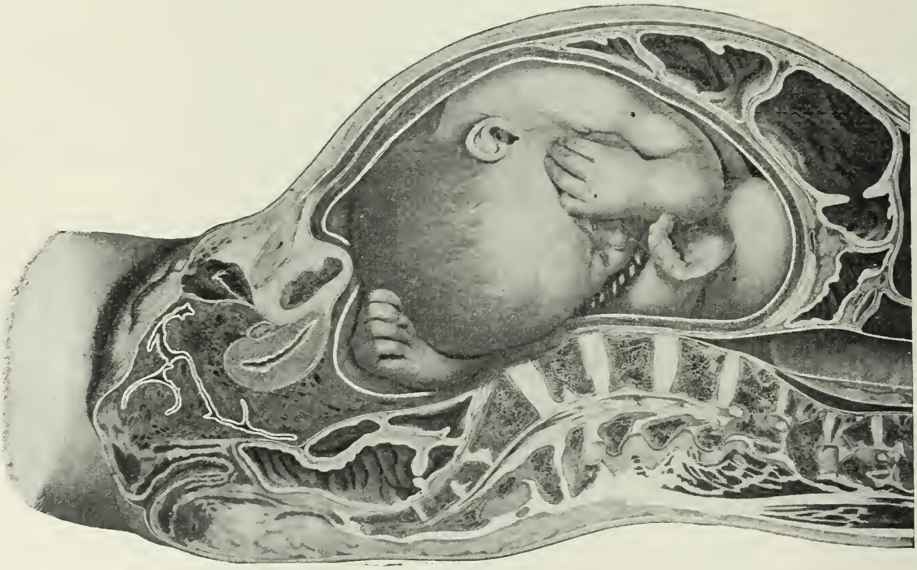


FIG. 702.—FROZEN SECTION THROUGH WOMAN DYING AT END OF PREGNANCY. COMPOUND PRESENTATION (Braune).

Compound Presentations.—By this term is understood the prolapse of an extremity alongside of the presenting part, both entering the pelvic canal simultaneously. It is not an infrequent occurrence, being observed about once in every 250 cases (Fig. 702).

As a rule, a hand or an arm comes down with the head; much less commonly both arms, or a hand and a foot, or both feet may present together. Hahl has reported a case in which the neck of the child was girdled by its legs, so that the scrotum and head were felt upon vaginal examination (Fig. 703).

Some idea of the relative frequency of the different combinations may be gained from the following table, taken from Pernice:

	Cases
Head and hand	26
Head and arm	8
Head, hand, and cord	5
Head and both hands	4
Head, one hand, and one foot	2
Head, two hands, one foot, and cord	1
Face, hand, and cord	1

Such a condition is frequently associated with disproportion between the size of the head and the pelvis, owing to which early engagement has been interfered with, and as a result one or more of the extremities have prolapsed before the presenting part entered the pelvis.

Treatment.—Whenever, during the first stage of labor, a hand is distinguished alongside of the head, the possibility of the existence of disproportion must be considered. If it is not present the hand should be pushed up if possible; but if it be firmly fixed between the head and the pelvic wall it should be left alone, since it will usually not interfere with labor. On the other hand, if the entire arm is prolapsed alongside of the head, an effort should be made to replace it. If, however, any considerable difficulty is experienced, the attempt should be abandoned, and version performed. This is more particularly indicated, since if the arm retains its position it may give rise to serious dystocia, more especially if it extends around the child's neck, constituting the so-called *nuchal position.*

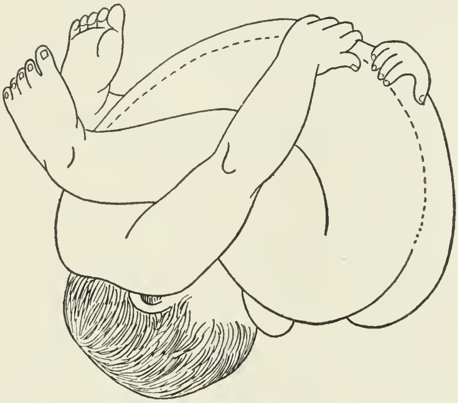


FIG. 703.—COMPOUND PRESENTATION (Hahl).

When, as happens only rarely, the foot prolapses, attempts to replace it are usually futile, and version should be promptly performed, after the hand *in utero* has determined the exact condition of affairs.

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CHAPTER XL

HEMORRHAGE

Profuse hemorrhage occurring prior to or shortly after the birth of the child is always a dangerous and sometimes a fatal complication. Practically all varieties of *antepartum hemorrhage,* with the exception of those originating from lacerations of the genital canal, are due to a partial or complete separation of the placenta from its attachment to the uterine wall. Such hemorrhage is an inevitable accompaniment of labor when the placenta is implanted in the neighborhood of the internal os—placenta prævia, but occasionally occurs when the organ occupies its normal site in the upper portion of the uterus.

PREMATURE SEPARATION OF THE NORMALLY IMPLANTED PLACENTA

Antepartum hemorrhage due to the premature separation of the normally implanted placenta has doubtless occurred from time immemorial, but its mode of production was first recognized by Louise Bourgeois in 1609. Particular attention was directed to it by Rigby, in 1776, who clearly differentiated it from the hemorrhage due to placenta prævia, and designated it as accidental, in contradistinction to the unavoidable hemorrhage associated with the latter condition. R. W. Holmes, of Chicago, proposed in 1901 to designate the process as *ablatio placentæ,* and many have accepted his suggestion.

As will be indicated below, the placenta may be completely or only partially detached from the uterine wall, and the effused blood may be entirely retained within the uterine cavity, or may escape externally through the vagina—concealed or external accidental hemorrhage. The former is one of the most serious accidents of pregnancy and labor, and fortunately occurs but rarely; while the latter is less serious, and in my experience occurs as frequently as hemorrhage due to placenta prævia. Goodell, in 1875, collected from the literature 106 instances of concealed accidental hemorrhage, demonstrated its great gravity, and indicated the impotence of the methods of treatment then in vogue. Holmes, in 1901, was able to collect 200 additional cases, but believed that his figures gave a very inadequate idea of the incidence of the accident. Subsequent investigation has proved the correctness of his prediction, and Dorman, Colclough and Essen-Möller in large series of cases observed premature separation of the placenta once in every 115, 207 and 216 labors, respectively; although clinical symptoms were lacking in one half of their cases, while concealed hemorrhage occurred in less than one case out of ten. In a series of 9000 patients delivered in my service prior to December, 1924, 57 cases of premature separation were noted, but in the last 40 of them there were only five examples of concealed accidental hemorrhage.

Etiology.—Unfortunately the primary cause of premature separation of the placenta is imperfectly understood, and the following conditions have been invoked as etiological factors: traumatism, shortness of the umbilical cord, profound mental emotions, endometritis, nephritis, toxemia, torsion of the uterus and histamine intoxication. Formerly it was held that a fall or a blow upon the abdomen might cause it, and traumatism was noted in 67 of the cases collected by Holmes, but was mentioned less frequently in the statistics of subsequent writers, and was lacking in all of my own cases. For this reason, I believe that its influence has been exaggerated, and, while it may occasionally be concerned, it cannot be regarded as the usual cause of the complication. In the classical specimen of Pinard and Varnier, the accident was clearly due to traction exerted upon the placenta by an abnormally short umbilical cord. Gardiner has laid great stress upon its importance, but as such an abnormality was lacking in all of my cases, as well as in most of those recorded in recent literature, it is evident that it can only exceptionally be an etiological factor. The older writers laid great stress upon the part played by sudden and intense mental emotions, but at present no one believes in the efficacy of such causes.

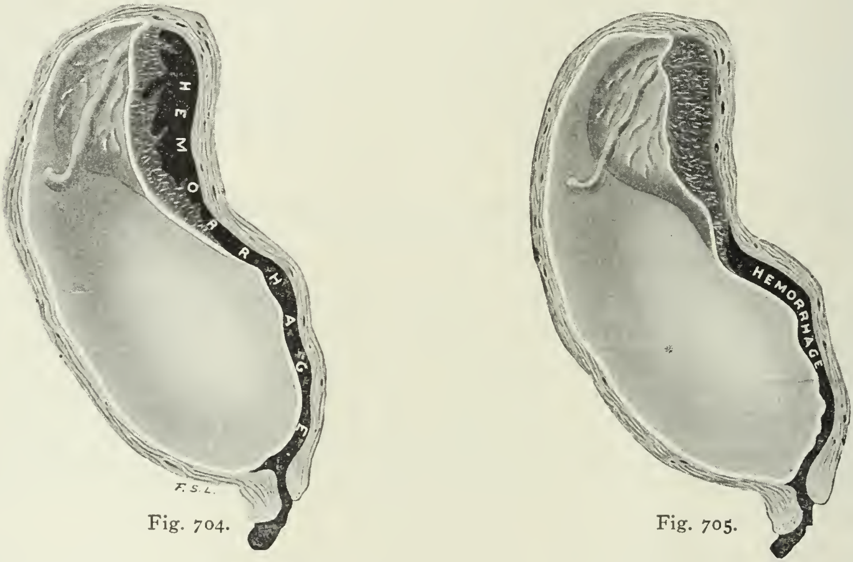


Fig. 704. Fig. 705.

Figs. 704, 705.—Premature Separation of Placenta with External Hemorrhage (Winter).

Many German authorities, particularly Weiss, Seitz and Schickele, hold that inflammatory or degenerative lesions in the decidua are responsible for the production of the accident. Doubtless, such changes are sometimes present; but as careful histological examination failed to reveal their presence in any of my specimens, I feel that they should be regarded as accidental complications.

Since Winter, in 1885, directed attention to the presence of albumin in the urine of patients suffering from this accident, chronic nephritis has been regarded as its most common cause, and various writers have reported that albuminuria was present in one-half to seven-eighths of their cases. Plausibility is lent to the argument by the well-known association of red infarcts of the placenta with chronic nephritis, and it has been suggested that similar hemorrhagic lesions occurring in the decidua afford a satisfactory explanation for the inauguration of the placental separations. Although albuminuria of varying degree was noted in 33 out of my 57 cases, chronic nephritis was present but twice. Consequently, I believe that the latter is rarely an etiological factor, and that the albuminuria should be regarded as an accidental complication, or as a manifestation of an acute toxemic process.

Bar, Couvelaire, Essen-Möller, Portes, Louros, Goethals, and others have observed premature separation in association with eclampsia, and many profess to regard the two as closely related and as due to the same toxemic process. I, however, regard such a view as too extreme for two reasons. First, that in a considerable proportion of cases, the urinary findings are negative and the blood pressure is not elevated either before or after the accident; and, second, that in none of my patients, who came to autopsy, could characteristic focal lesions be found in the liver. On the other hand, it must be admitted that in some instances such an association occurs. In my contribution of 1915, I stated that peculiar degenerative lesions observed in the intima of the smaller uterine arteries suggested the possibility that the condition might be due to a peculiar type of toxemia which caused vascular changes; but I regret to state that similar lesions could not be found in subsequent specimens.

It is generally stated that multiparity appears to be a predisposing cause, as only 19.2 per cent of the cases collected by Holmes were noted in primiparæ, but the fact that the incidence was 30 per cent in my series would appear to invalidate such claims.

Morse, in 1918, was able to produce in experimental animals a condition somewhat similar to the "uteroplacental apoplexy," to be described in the next section, by ligating certain uterine vessels or by producing torsion of one horn. He therefore attributed the lesion to a similar cause, but to my mind his argument is fallacious, for the reason that torsion of the uterus was not present when the abdomen of any of my patients was opened, but more particularly because hemorrhagic lesions were absent from a uterus, which Britz found had been rotated to such an extent that its posterior surface lay in contact with the anterior abdominal wall. Consequently, I believe that Morse's experimental lesions are comparable to those with which we are so well acquainted following twisting of the pedicle of ovarian tumors.

Most of the conditions just mentioned may come into play either during pregnancy or at the time of labor. On the other hand, certain other etiological factors cannot become operative until labor has set in. Among these may be mentioned traction exerted by an abnormally short umbilical cord, as well as a sudden diminution in the bulk of the uterine contents following the birth of the first child in a twin pregnancy or the too rapid expulsion of a large amount of amniotic fluid in hydramnios.

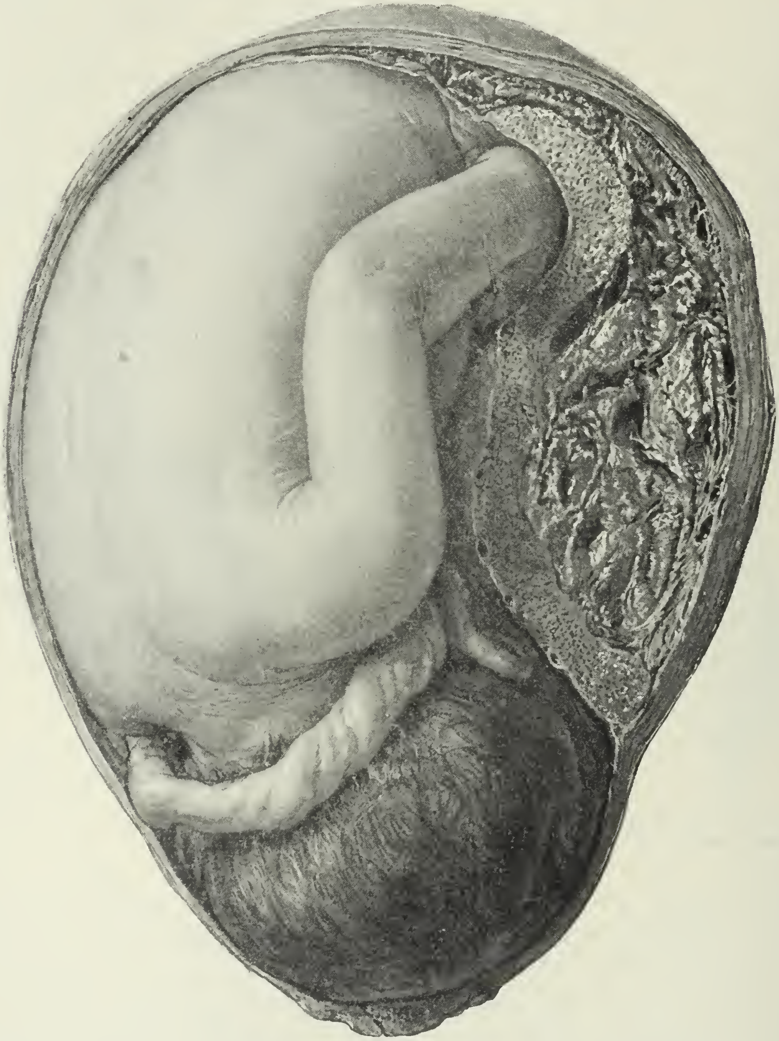


Fig. 706.—Premature Separation of Placenta with Concealed Hemorrhage. Uterus Removed by Supravaginal Amputation. × ½.

Hofbauer, in 1926, by the injection of weak solutions of histamine, produced highly suggestive lesions in experimental animals, and believes that the same agent may be operative in women, more especially as he holds that histamine may be produced by degenerative changes occurring in the chorionic tissues of the placenta. While his theory is suggestive and interesting, it should not be accepted until further evidence is adduced in its support.

Pathology.—Premature separation of the placenta is inaugurated by an effusion of blood into the decidua basalis, which sometimes appears to come from areas of hemorrhage within the placenta itself—red infarcts—and at other times from alterations in the permeability of the smaller uterine vessels. The decidua then splits, so that a thin layer remains in contact with the maternal surface of the placenta while a thicker layer adjoins the muscularis. Consequently, the process in its earliest stages consists in the development of a decidual hematoma, which leads to separation, compression and ultimate throwing out of function of the portion of the placenta adjacent to it. In its early stage there are no clinical symptoms, and the condition is discovered only upon examination of the freshly delivered organ, which will present on its maternal surface a sharply circumscribed depression, measuring a few centimeters in diameter, and containing dark and partially disorganized, clotted blood. In most instances the decidual hemorrhage is more profuse, so that the area of separation becomes more extensive, and gradually extends to the margin of the placenta. As the uterus is still distended by the product of conception, it is unable to contract and compress the torn vessels in the decidua basalis, and, consequently, the escaping blood makes its way between the membranes and the uterine wall and eventually appears externally. Less often, the blood is retained within the uterus. This is designated as concealed accidental hemorrhage and is liable to occur (1) when there is an effusion of blood behind the placenta, its margins still remaining adherent; (2) when the placenta is completely separated, while the membranes retain their attachment to the uterine wall; (3) when the blood gains access to the amniotic cavity after breaking through the membranes; and (4) when the head is so accurately applied to the lower uterine segment that the blood cannot make its way past it. In the majority of such cases, however, the membranes are gradually dissected off from the uterine wall, and part of the blood eventually escapes from the cervix.

Formerly, in considering the pathology of the condition, attention was centered upon the extent of the separation—partial or complete—and whether the hemorrhage was external or concealed. Following the observations of Couvelaire, Essen-Möller, myself, and others, it is now recognized that, in certain cases at least, characteristic lesions occur in the uterine wall, which serve to explain not only the mode of origin of the separation, but also the failure of the organ to contract after being emptied of its contents. The uterus, and occasionally the tubes and ovaries as well, take on a bluish, purplish coppery coloration and resemble an ovarian cyst with a twisted pedicle (Plate XVI). The process may likewise involve one or both broad ligaments, as well as the tubes and ovaries, which are then gorged with blood. In many instances the uterus fails to contract and retract following cesarean section, and, as it remains as soft and flabby as a piece of wet leather, one is forced to amputate it supravaginally in order to prevent death from hemorrhage. In such cases, microscopic examination shows extensive intramuscular hemorrhage, which has so dissociated the muscle fibers as to destroy completely their contractile properties (Fig. 707). Furthermore, similar hemorrhagic changes in the decidua basalis afford a ready explanation for the inauguration of the process of separation. In most specimens the hemorrhagic discoloration is greatest in the area corresponding to the placental site, and the muscular disassociation is most pronounced in the outer and inner layers of the uterine wall.

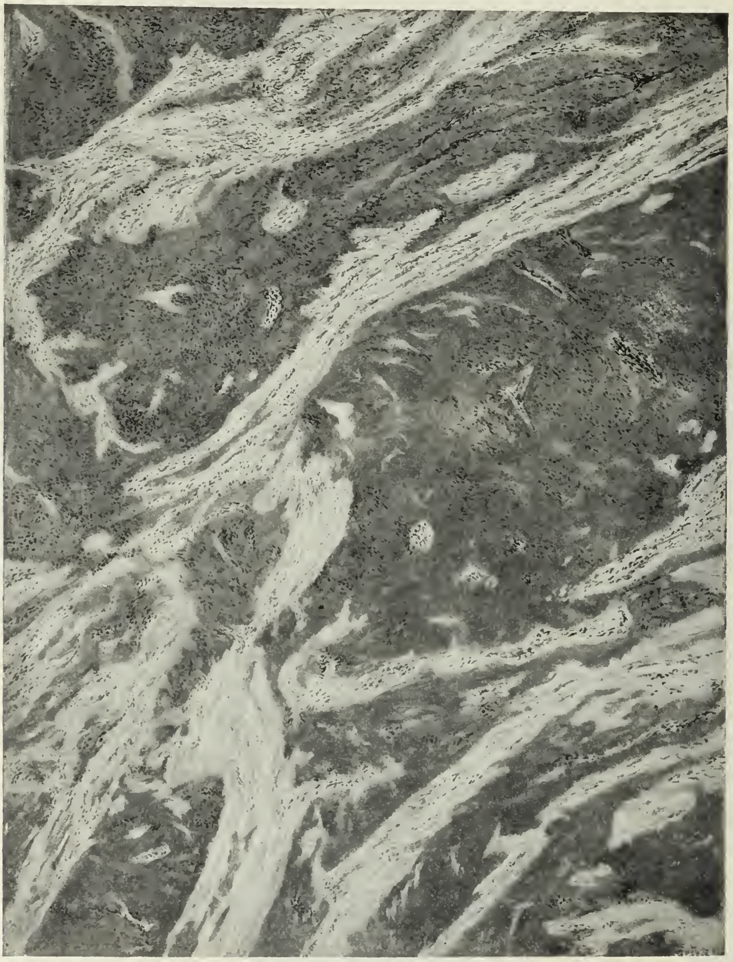
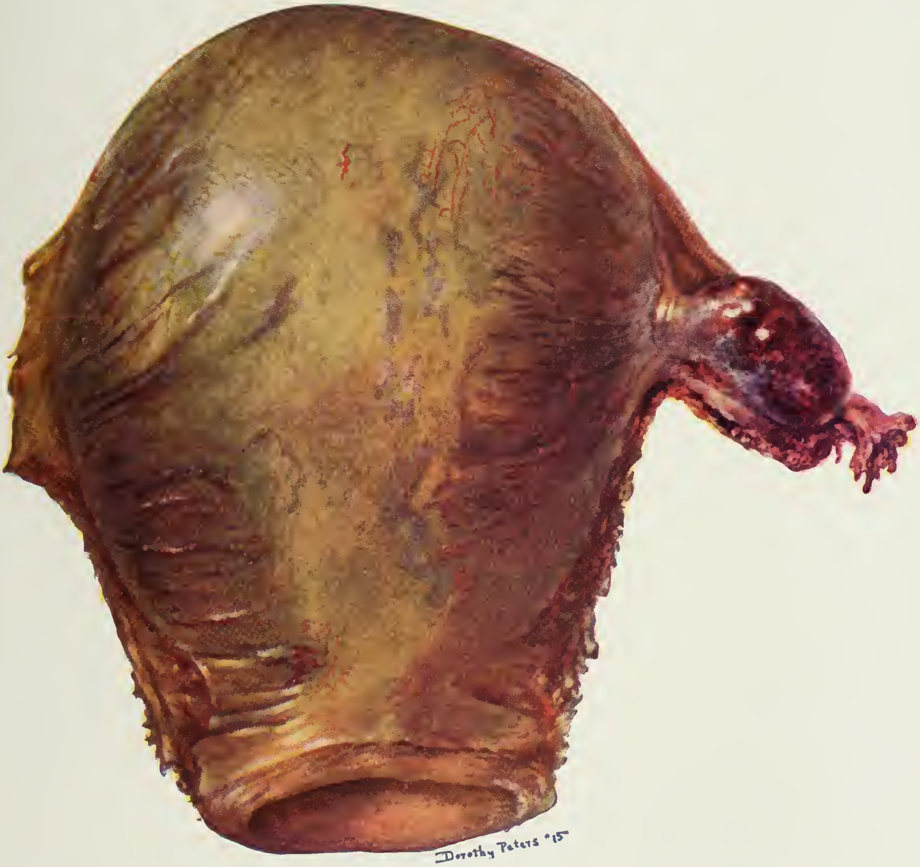


Fig. 707.—Section through Uterine Wall from a Case of Premature Separation of the Normally Implanted Placenta, Showing Dissociation of the Muscle Fibers by Hemorrhage.

Light areas represent muscle, dark areas effused blood. × 40.

Couvelaire has designated the condition as uteroplacental apoplexy. Its mode of production is not yet clear, but as has already been indicated, it appears

PLATE XVI.


Dorothy Peters '15

HEMORRHAGIC CHANGES IN UTERUS ASSOCIATED WITH PREMATURE SEPARATION OF THE PLACENTA.

to be associated with a toxemic process; and in several of the uteri which I examined, endarteritic changes and lesions of continuity in the smaller vessels afforded a satisfactory explanation for the production of the intramuscular hemorrhage. It is not yet known whether uteroplacental apoplexy is a constant lesion, but it is my belief that it occurs only in the more serious cases. That it is not infrequent is shown by the fact that in the four years preceding the appearance of my article in 1915, twenty such specimens had been described, and that Portes was able to collect 73 cases in 1923, while I see one or more such uteri each year.

Occasionally, as described by Knauer and Fraipont, superficial longitudinal fissures develop upon the surface of the uterus. These are usually multiple, a few centimeters in length, and extend only a slight distance into the muscularis. It is not yet known whether they are due to excessive distention of the organ or to the rupture of the superficial hemorrhagic areas; but, whatever their mode of production, they occasionally lead to fatal intraperitoneal hemorrhage, as recorded by McNair, Oldfield and Shaw.

Clinical History.—Premature separation of the placenta may occur during the later months of pregnancy or at the time of labor. In the former case the resulting external or concealed hemorrhage is soon followed by the onset of uterine contractions. Fortunately, in most cases the loss of blood is moderate, but if it is marked, the patient presents signs of acute anemia, and passes into a condition of profound shock which may end fatally if delivery is not effected promptly. In many instances, the degree of shock is out of proportion to the amount of blood lost, and consequently appears to be the result of traumatism rather than of hemorrhage. For example in the patient from whom Figure 706 was obtained, the retroplacental hematoma did not contain more than 500 cubic centimeters of blood, yet the pulse was 140 when she was admitted to the service.

In concealed hemorrhage the first symptom often consists in intense, coliclike abdominal pain, and on palpation the uterus presents a boardlike, almost ligneous consistency, and no longer alternates between contraction and relaxation, so that the outlines of the child cannot be distinguished. As the child is dead, auscultation gives negative results. Occasionally, the uterus gradually enlarges and eventually attains a size considerably larger than would normally correspond to the duration of the pregnancy. Particular attention should be paid to the pain and to the consistency of the uterus, as signs of shock do not usually appear until later. Ligneous consistency of the uterus does not always develop, but in my experience its presence is pathognomonic. On the other hand, when the hemorrhage is external, the pain is less severe, there is little enlargement of the uterus, whose consistency may or may not be changed. In concealed hemorrhage the pain and shock are often attributed to other conditions, and the patient sometimes dies before the condition is diagnosticated.

When the premature separation of the placenta occurs at the time of labor as the result of traction upon an abnormally short cord, or of the sudden partial emptying of the uterine cavity in twin pregnancy or hydramnios, the hemorrhage is usually external, and the fœtal heart sounds suddenly become imperceptible.

In very exceptional instances the placenta may become separated from its attachment during the course of an otherwise normal labor, and be extruded in front of the child. No doubt most of the recorded cases were really instances of placenta prævia, although now and again, as in the case reported by Münchmeyer, such an accident may occur even when the placenta is inserted normally —*prolapse of the placenta.*

Diagnosis.—In the absence of external bleeding, the occurrence of sharp abdominal pain associated with a uterus of ligneous consistency, in a patient in the latter months of pregnancy, is almost pathognomonic of concealed accidental hemorrhage, and the diagnosis becomes assured when the patient develops signs of acute anemia with manifestations of shock. While the last-mentioned symptoms may follow the rupture of an advanced extra-uterine pregnancy, or the very exceptional spontaneous rupture of the uterus, such conditions can be excluded if the uterus presents the characteristic boardlike consistency.

When, however, the hemorrhage is external, the diagnosis is rendered practically positive by the failure to demonstrate the presence of a placenta prævia on vaginal examination, though, of course, it is impossible to differentiate the rare cases of rupture of the circular sinus of the placenta to which Budin has directed our attention.

In the exceptional instances in which the hemorrhage is entirely retroplacental a localized elevation of the corresponding portion of the uterine wall can occasionally be detected on palpation.

Prognosis.—Concealed accidental hemorrhage is one of the most serious complications of pregnancy and labor, many of the mothers and practically all of the children perishing, Goodell having reported a maternal and fœtal mortality of 50.9 and 94.4 per cent, respectively. Even now the results are not good, as in the 47 radical operations collected by Portes the mortality was 36 and 81 per cent, respectively, and even when the condition is promptly recognized and properly treated, a maternal mortality in the neighborhood of 10 per cent is not excessive. This is due to the fact that the mere completion of delivery is not synonymous with safety, as a certain proportion of patients succumb to atonic postpartum hemorrhage, while others die from unrecognized intraperitoneal bleeding.

On the other hand, when the hemorrhage is external, the prognosis is dependent upon the amount of blood lost. It should always be remembered that in many cases the loss of blood is very moderate and the area of separation not great enough to interfere with the life of the child. Indeed, in not a few cases, the first intimation of the existence of the condition is the discovery of a depressed area upon the maternal surface of the placenta when examined after its extrusion. Not all cases, however, end so satisfactorily, as in some the external hemorrhage indicates that blood has escaped from a large retroplacental hematoma, which has slowly separated the membranes from the uterine wall.

Treatment.—In the more serious forms the life of the mother can be saved only by prompt evacuation of the uterus, as only then can the organ contract down and check the bleeding. On the other hand, when the separation is partial and the loss of blood but slight, the accident may be without serious significance. In the latter class of cases an expectant treatment should be pursued, and labor allowed to take its natural course, interference being indicated only when the symptoms become urgent.

On the other hand, if the patient presents signs of acute hemorrhage, whether of the concealed or external variety, the uterus should be emptied with the least possible delay. If labor has not yet set in, abdominal cesarean section should be performed; and the uterus retained or removed, according as it contracts satisfactorily or remains atonic. The same applies even if labor is already in progress, unless the cervix is partially dilated and so softened that manual dilatation can be readily and safely effected, following which the child should be delivered by version or forceps, as seems advisable. The use of rubber balloons is rarely indicated on account of their slow action. Radical operative treatment is the more justified, for the reason that no one can predict to what extent the uterine muscle may be disorganized by hemorrhage, so that in many cases only the amputation of the uterus can prevent death from postpartum hemorrhage. At the same time it should be remembered that after cesarean section approximately three uteri out of four retract sufficiently rigorously to justify their retention.

In severely shocked patients morphia should be promptly administered as recommended by Cameron, and the cesarean deferred until a blood transfusion has been given. The operation should be done under local anesthesia if possible, and nitrous oxide and oxygen should be preferred to ether or chloroform. In any event, unless the condition of the patient is unusually satisfactory, blood should be transfused after completing the cesarean. From my own experience, I feel that a certain number of women have been lost by failure to observe such precautions.

In some instances, following delivery through the natural passages, the tonicity of the uterus has been so impaired by the dissociation of its fibers by intramuscular hemorrhage that it fails to contract and retract during the third stage of labor, and as a result profuse postpartum hemorrhage may follow. This possibility should always be borne in mind, and the operator should have in readiness the necessary materials for packing the uterus at a moment's notice. If, however, bleeding continues in spite of the pack, no time should be wasted in palliative expedients, but the abdomen should be opened at once and the uterus amputated. In such cases, the outlook is not so promising as if the uterus had been removed primarily.

PLACENTA PRÆVIA

It is generally stated that the most common cause of antepartum hemorrhage is the partial separation of a placenta implanted in the neighborhood of the internal os—placenta prævia.

Our knowledge concerning this abnormality may be said to date from the end of the seventeenth and the beginning of the eighteenth centuries, Portal, in 1685, and Schacher, in 1709, having accurately described the condition from a clinical and an anatomical point of view. Notwithstanding the fact that Smellie, William Hunter, and Rigby were well acquainted with placenta prævia and its dangers, very little advance was made in our knowledge concerning it until Barnes promulgated his views as to its mode of production and the methods of controlling the hemorrhage arising from it. Since then many investigators have busied themselves in determining its etiology and the most suitable treatment. An excellent historical résumé is contained in the monographs of von Herff and Hofmeier.

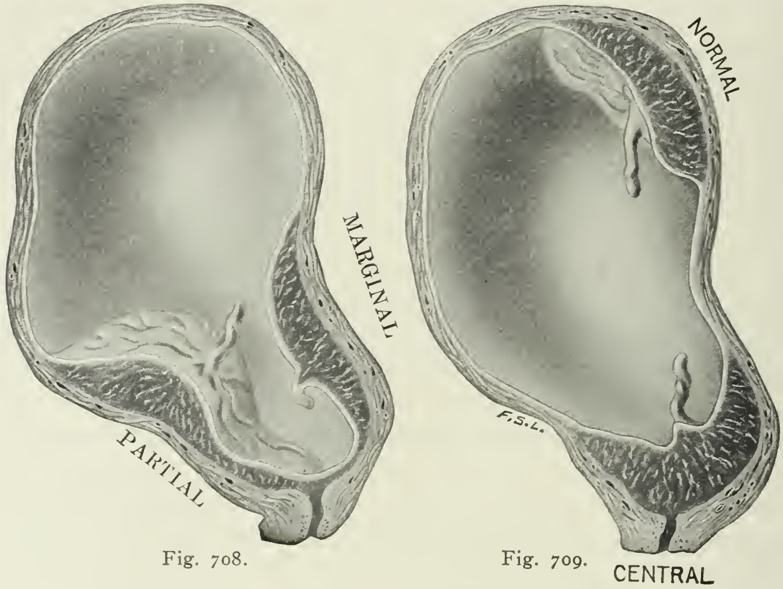


Fig. 708. Fig. 709.

Figs. 708, 709.—Showing Different Modes of Placental Insertion. (Modified from American Textbook.)

In this condition, the placenta, instead of being implanted high up upon the anterior or the posterior wall of the uterus, overlaps the internal os to a greater or lesser extent, thereby becoming accessible to the examining finger. Ordinarily, three varieties are distinguished: *Placenta prævia centralis, lateralis* or *partialis,* and *marginalis.* In the first the internal os is completely covered by placental tissue, which is adherent to its margins; in the second the placenta encroaches more or less upon the internal os, but does not completely cover it;

while in the third the placenta is implanted higher up, its lower margin just over lapping the internal os (Figs. 709 and 710).

Strictly speaking, the differentiation between the several varieties should not be made until the cervix has become fully dilated, for the reason that the marginal variety cannot be felt until this has occurred; while what may appear to be a complete placenta prævia during pregnancy or the first part of labor may prove to be only partial, and to encroach only slightly beyond the margin of the internal os when dilatation is complete. In both the central and partial varieties, partial separation of the placenta is an inevitable consequence of the formation of the lower uterine segment and the dilatation of the cervix. This is always associated with the tearing through of blood vessels, which cannot become constricted until after the uterus has been emptied, so that the resulting hemorrhage was appropriately designated by Rigby as *unavoidable*. In placenta prævia marginalis, on the other hand, hemorrhage does not always occur, and, as the placental tissue can be felt only after dilatation has proceeded to a certain extent, the existence of the condition is frequently unrecognized. Such cases are closely related to the so-called *vicious insertion* of the placenta described by Pinard and his pupils, which is of frequent occurrence.

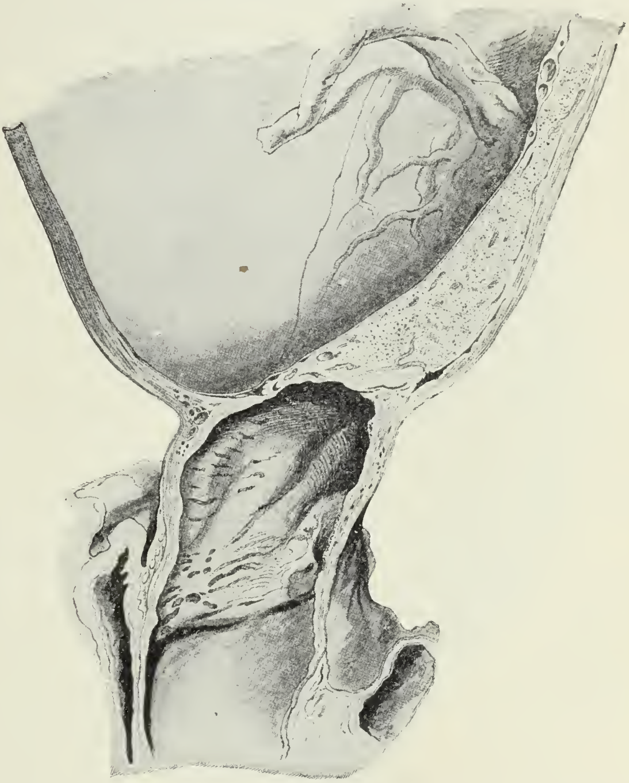


Fig. 710.—Partial Placenta Prævia, in which No Attempt at Delivery Had Been Made (Ahlfeld)

Frequency.—Placenta prævia is fortunately a comparatively rare complication, although the statements as to its frequency vary considerably. Thus, W. Müller, whose statistics were based upon 876,432 labors, stated that it occurs once in 1078 cases; while Lomer, Tarnier, and Bürger and Graf, on the other hand, estimated its incidence as once in 723, 207, and 130 labors respectively. In general it would be approximately correct to say that it is met with about once in 1000 cases in private, as compared with once in 250 cases in hospital practice.

Moreover, there is considerable variation in the statements concerning the relative incidence of the several varieties, though it is usually held that the partial form is the most frequent. Thus, Koblanck, Strassmann, and Bürger and Graf observed the central variety in 18.4, 23.8, and 18.4 per cent, the partial in 64.5, 61.5 and 36 per cent, and the marginal in 17.1, 15.2, and 45.6 per cent of their placenta prævia cases respectively. Pinard, on the other hand, states that he has never met with a placenta which was uniformly adherent to the margins of the internal os and that the marginal is the most frequent variety. In favor of this view he adduces the fact that he had observed the so-called vicious insertion in 28.12 per cent of all normal labors. Such conclusions must, however, be accepted with reserve, since they are based upon the measurement of the distance of the margin of the placenta from the point of rupture of the membranes, as determined from the examination of the after-birth, and it is clear that such a mode of investigation is not beyond reproach.

Etiology.—Concerning the etiology of placenta prævia comparatively little is known. Two factors, however, appear to favor its occurrence—multiparity and so-called endometritis.

The abnormality occurs comparatively rarely in primiparæ, and increases in frequency with the number of children which the individual has borne. This point is strikingly illustrated by the following figures of Doranth, which were based upon 30,796 labors occurring in Chrobak's clinic. In these the incidence of placenta prævia was 0.17, 0.48, 1.37, 1.28, 3.39, and 5.51 per cent, according as the patients had given birth to 1, 2, 3, 4, 5, 6, or 7 or more children, respectively.

The occurrence of placenta prævia is not only favored by the absolute number of children, but also by the rapidity with which the labors have followed one another, Strassmann finding that the average age of his patients was 32.9 years, and that the average number of labors was 6.38. In 55 multiparous women with placenta prævia in our service it was found that they had averaged 5.9 children each in the ten years following the first delivery.

Strassmann also pointed out that one of the most important factors in its development was to be found in defective vascularization of the decidua, the result of inflammatory or atrophic changes, the latter being favored by repeated and closely following pregnancies. Such conditions, he maintained, limit the amount of blood going to the placenta, so that in order to obtain the requisite supply of nutriment it becomes necessary for it to spread over a larger area of attachment, and in so doing its lower portion occasionally approaches the region of the internal os, completely or partially overlapping it as the case may be. Plausibility is lent to such a view by the fact that the placenta in this abnormality is attached over a greater area of the uterus than usual, while at the same time it is often considerably thinner. Thus, in one of my cases which came to autopsy, the placenta was almost membranous, and its site occupied nearly four-fifths of the interior of the uterus.

The older authorities believed that placenta prævia was due to the separation

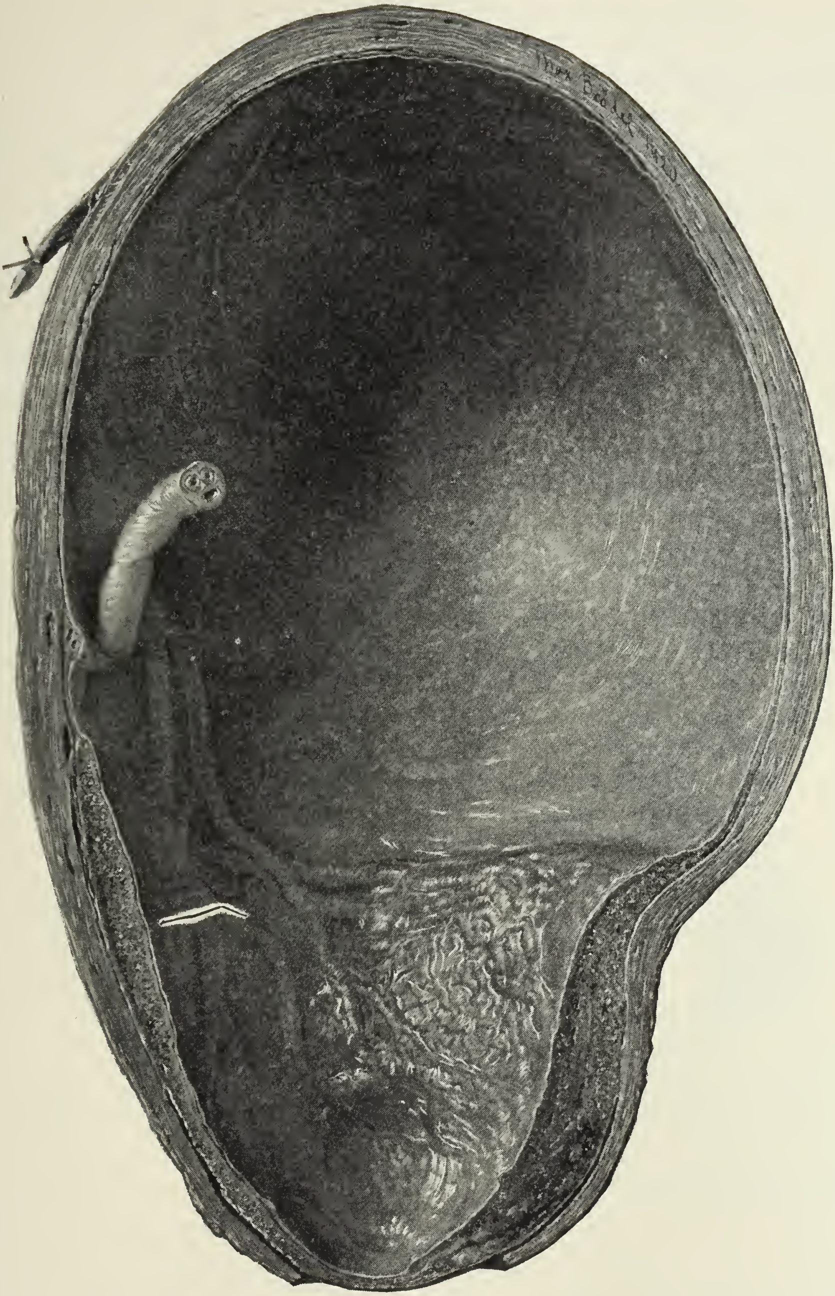


FIG. 711.—RIGHT HALF OF UTERUS WITH CENTRAL PLACENTA PRÆVIA AND VELAMENTOUS INSERTION OF CORD.

Note the cuplike form of the placenta and its varying thickness. × ⅗.

from its attachment of a normally implanted ovum, which, falling to the lower portion of the uterus, subsequently contracted new connections instead of escaping through the cervix. Later it was urged that such a view failed to explain the production of the central variety, as it was inconceivable that the escape of the minute ovum from the uterus could be delayed sufficiently long to permit the formation of attachments in the neighborhood of the internal os. The fallacy of this view is apparent when one recalls the fact that the uterus at the time of conception is normally so anteflexed that the region of the internal os is at a higher level than the fundus, hence the force of gravity would not necessarily aid in carrying the ovum towards the cervix. Furthermore, Bumm contended that, in view of the congested condition of its margins, the internal os is smaller than the fertilized ovum.

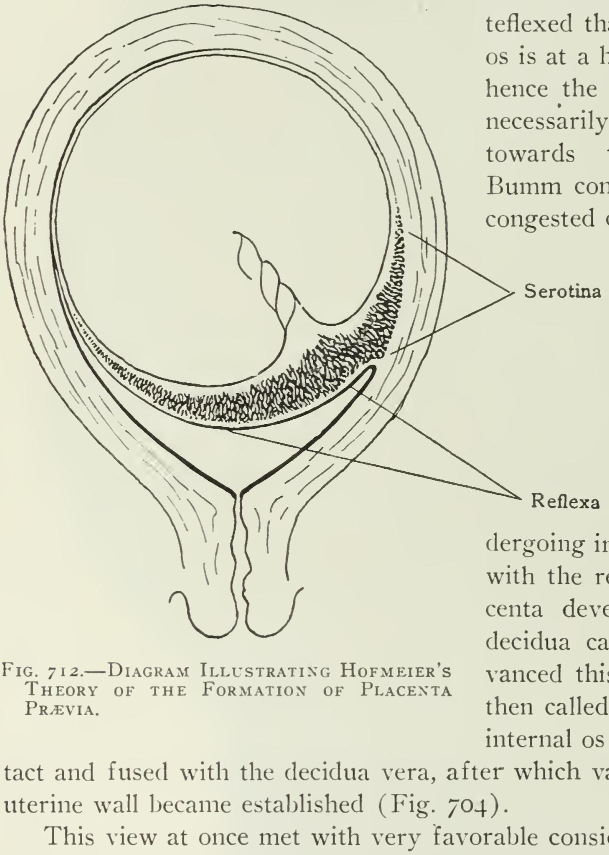


Fig. 712.—Diagram Illustrating Hofmeier's Theory of the Formation of Placenta Prævia.

The gravitation theory was generally accepted until 1888, when Hofmeier and Kaltenbach advanced the theory that a part of the chorion læve continued to grow instead of undergoing involution early in pregnancy, with the result that a part of the placenta developed in contact with the decidua capsularis. As pregnancy advanced this *reflexa placenta,* as it was then called, gradually bridged over the internal os and eventually came in contact and fused with the decidua vera, after which vascular connections with the uterine wall became established (Fig. 704).

This view at once met with very favorable consideration, and Jolly, in 1911, advanced incontrovertible proof of its correctness in many cases. When Hofmeier advocated this mode of origin at the 1897 meeting of the German Gynecological Congress, he was careful to state that it was not the only manner in which a placenta prævia might originate; inasmuch as in certain instances the extension of the placental area might be effected by a process of cleavage in the decidua vera, as the result of which the margin of the organ would extend beyond the basalis. Should such cleavage extend downward, it was readily conceivable that the placenta might grow on either side of the internal os, and, eventually, completely cover it. At that time correct information concerning the mode of implantation of the ovum and of the growth of the placenta was not available, and Hofmeier was not aware that a somewhat analogous cleavage occurs in every normal pregnancy.

In view, therefore, of our present knowledge concerning the normal implantation of the ovum, as well as of Strassmann's theoretical deductions, it appears probable that placenta prævia results either from the primary implantation of the ovum in the lower portion of the uterus, associated with such extensive cleavage of the decidua vera that the extension of the placenta to the region of the internal os is facilitated, or that it results from the development of a part of the placenta upon the internal surface of the decidua capsularis.

Very exceptionally as reported by Ponfick, Kermauner, and Zangemeister and Schilling, a part of the placenta is developed upon the upper portion of the cervix. The possibility of such an occurrence must be admitted, although Ahlfeld and Aschoff have shown that it is more apparent than real, as it is not due to a primary implantation, but rather to a secondary cleavage of the cervix by the extension of a placenta which had been primarily implanted above it. This peculiarity readily accounts for the difficulty sometimes experienced in the manual removal of such placentæ, as was pointed out by Neumann.

Symptoms.—The most characteristic symptom of placenta prævia is hemorrhage, which usually does not appear until after the seventh month of pregnancy. At the same time it is probable that many abortions are due to this abnormality, although the true state of affairs usually escapes observation. I have seen several abortions in the third month which were clearly due to it.

The hemorrhage frequently comes on without warning in a pregnant woman who had previously considered herself in perfect health. Occasionally it makes its first appearance while the patient is asleep, so that on awakening and feeling the bedclothes moist, she is surprised to find that she is lying in a pool of blood. Ordinarily, the initial bleeding is rarely so profuse as to prove fatal, and ceases spontaneously, to recur again when least expected. In other cases the bleeding

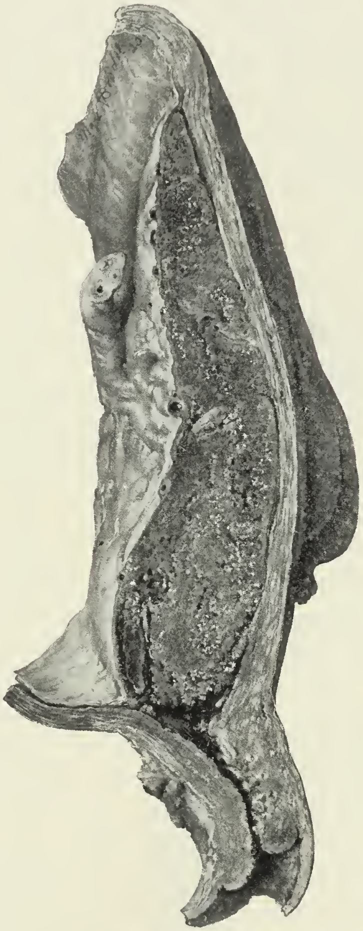


FIG. 713.—SAGITTAL SECTION THROUGH CERVIX AND POSTERIOR WALL OF UTERUS SHOWING PARTIAL PLACENTA PRÆVIA.

Note the area of separation just above internal os, which was sufficient to cause fatal hemorrhage. × ½.

does not cease entirely, there being a continuous discharge of small quantities of bloodstained fluid, which eventually so weakens the woman that a comparatively slight additional, acute hemorrhage may be sufficient to cause death. In a certain proportion of cases, particularly when the insertion is marginal, the bleeding does not appear until the time of labor, when it may vary from a slight, bloodstained discharge to a profuse or even fatal hemorrhage. As a rule, it is less copious in this than in the other varieties.

The mode of production of the hemorrhage is readily understood when one recalls the changes which take place in the later weeks of pregnancy and at the time of labor. When the placenta is inserted centrally or partially, it is evident that, as the formation of the lower uterine segment and the dilatation of the internal os progress, its attachments must inevitably be torn through, the rupture being necessarily followed by a hemorrhage from the maternal vessels. Furthermore, the bleeding is favored by the fact that it is impossible for the stretched fibers of the lower uterine segment to compress the torn vessels, as is the case when the normally implanted placenta becomes separated during the third stage of labor. Moreover, when the placenta has developed in the capsularis, it is apparent that the thin tissue is devoid of all support where it bridges over the region of the internal os, and consequently a slight trauma will open up the intervillous space.

As the placenta prævia occupies the lower portion of the uterine cavity, it interferes with the accommodation of the fœtal head, and consequently abnormal presentations are unusually frequent, Müller having noted 272 transverse and 107 breech presentations in 1148 cases.

In normal labor all danger is ordinarily past with the completion of the second stage. In placenta prævia, on the other hand, as a result of abnormal adhesions or an excessively large area of attachment, the process of separation is sometimes interfered with, so that profuse hemorrhage frequently occurs after the birth of the child, and exceptionally continues even after the manual removal of the placenta. In other cases hemorrhage is due to the fact that the overstretched lower segment, which normally retracts but poorly, is unable to compress the vessels traversing its walls.

Diagnosis.—In patients suffering from uterine hemorrhage during the last third of pregnancy, placenta prævia or the premature separation of the normally implanted placenta should always be suspected, and the possibility of the existence of the former should not be dismissed until careful examination has demonstrated its absence, in which event the latter condition should be diagnosticated. In the great majority of cases of placenta prævia the cervix is softer and more succulent than usual, and its canal more patulous, so that but little difficulty is experienced in carrying the finger through the internal os and feeling the characteristic spongelike placental tissue, or at least making out a soggy, thick substance lying between the finger and the presenting part. When, however, the cervix is not patulous it should be dilated, under anesthesia if necessary, sufficiently to permit the introduction of the finger, which is then passed through the internal os and swept around the adjacent portion of the lower uterine segment, when the presence or absence of the abnormality can be positively determined. It is true that such a procedure occasionally results in the induction of premature labor; but the risk is justifiable, since we possess no other means of arriving at a definite diagnosis, which should be made at any cost on account of the very serious menace which the existence of the condition offers to the life of the patient.

Prognosis.—The prognosis is always serious. According to Müller, under expectant treatment the maternal mortality varied from 36 to 40 per cent, while for the children it was about 66 per cent, one-half of those which were born alive perishing within the first ten days following delivery. The danger to the mother arises primarily from hemorrhage, which is usually the direct result of the condition, though frequently it may be increased by deep cervical tears resulting from too hasty artificial dilatation, or from the extraction of the child through an imperfectly dilated cervix. Moreover, such patients are particularly prone to puerperal infection, which is favored by manipulations incident to arresting the bleeding, as well as by the presence of the thrombosed sinuses in the lower uterine segment.

The fœtal mortality is due in part to the fact that the accident so frequently comes on while the children are quite premature. In other instances they perish from asphyxiation, the result of placental hemorrhage, occasionally succumbing during attempts at extraction through an imperfectly dilated cervix.

Nowadays the maternal mortality depends upon the variety of the placenta prævia, the method of delivery, and the condition of the patient when first seen. Thus, in 178 cases reported by Hofmeier, Behm, and Lomer, and treated by 11 different obstetricians by Braxton Hicks's method of combined version, the maternal mortality was 4.5 per cent. Jellett has reported a death rate of 3.69 per cent in 138 cases treated at the Rotunda in Dublin, and Essen-Möller 1 of 3.7 per cent in 132 cases. Stratz reported 1 death out of 110, Irving 2 out of 57, and Bill 1 out of 56 cases, which they had delivered personally. Krönig and Sellheim, on the other hand, report that 8 to 10 per cent of the patients die from hemorrhage, if not treated by cesarean section; while Pankow found a mortality of 7 per cent out of a series of 7234 cases, which he collected from the German clinics in 1926.

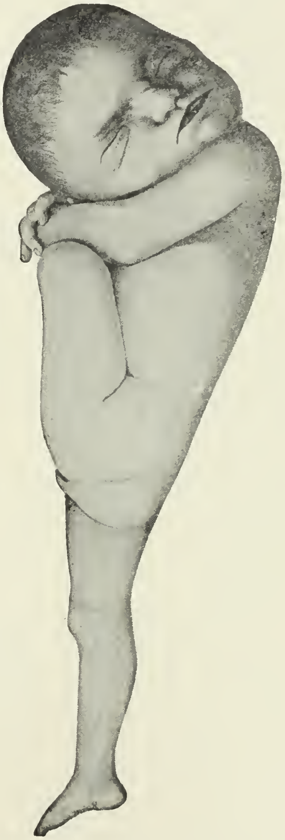


Fig. 714.—Fœtus Partially Extracted from a Patient Dying of Placenta Prævia, Showing How It Acts as a Tampon (Leopold).

In hospital practice, where many patients are admitted after inefficient treatment by poorly trained practitioners, in addition to acute anemia, puerperal infection plays a large part in increasing the maternal mortality. Thus, it was responsible for 40 and 71 per cent of the deaths reported by Bürger and Graf, and by Bar, respectively. The prognosis is much more serious in central placenta prævia than in the other varieties. Furthermore, the mortality depends upon the condition of the patient when first seen, it being evident that women who have suffered from profuse and repeated bleeding have far less chance of recovery than those who come under observation after the first slight hemorrhage.

Unfortunately, the fœtal mortality has shown comparatively little decrease in recent years, Küstner, Bürger and Graf, and Strassmann giving percentages of 35, 55, and 61.22 respectively. This high mortality rate is utilized by many as an argument in favor of cesarean section, and it must be admitted that its frequent employment will lead to some diminution. At the same time, only the most optimistic can look forward to very great improvement in this respect on account of the large number of premature children with which one has to deal, as Thompson's analysis of our material showed that the proportion between premature and mature children was as 8 to 1.

Treatment.—In my opinion the chief means of reducing maternal mortality from this complication consists in sending the patient to a well-equipped hospital for treatment, as it is difficult in the homes of the poor, as well as of the middle-class, to utilize properly blood transfusion and other measures which have proved so valuable in serious cases. On account of the danger of profuse and unexpected hemorrhage, pregnancy or labor, as the case may be, should be terminated in the most conservative manner as soon as possible after a positive diagnosis has been made. There is no single method of treatment applicable to all classes, and the obstetrician who understands how to differentiate his cases will obtain the best results.

If the diagnosis is made during pregnancy, treatment will depend upon whether the child is viable or not. In the former case discussion may arise as to whether cesarean section or a more conservative obstetrical procedure is preferable. If one has to deal with an undilated cervix and a complete placenta prævia the former appears indicated, as it will not diminish the chances of the mother and will enable us to guarantee the birth of a living child. On the other hand, if the cervix is sufficiently dilated to permit the introduction of two fingers, and we have to deal with the partial or marginal variety, almost ideal results are obtained by the introduction of a large Champetier de Ribes balloon after rupture of the membranes, dilatation being hastened by attaching a two-pound weight to the end of the tube by a string and suspending it over the foot of the bed. After the expulsion of the bag, if the head is engaged and there is no serious bleeding, spontaneous delivery may be awaited, or the child may be delivered at once by version and extraction.

On the other hand, if the child is not viable, equally good maternal results are obtained by bringing down a foot by Braxton Hicks's maneuver and using the breech of the child as a tampon to control further bleeding. If the hemorrhage ceases after the foot has been brought down, the expulsion of the child may be left to Nature; but if the oozing continues, gentle traction should be made upon the leg so as to compress the placenta with the child's buttocks. Whichever method is employed, extraction should not be attempted until the cervix is completely dilated, or at least sufficiently so as to permit the ready passage of the head. Too great haste is liable to cause deep cervical tears, giving rise to additional hemorrhage and requiring the application of sutures, while in other instances serious difficulty may be encountered in delivering the child.

Generally speaking, better results will be obtained in private practice by the employment of Braxton Hicks's bipolar version, no matter what the condition of the child may be, for the reason that the average practitioner will rarely be equipped with a suitable balloon and the necessary paraphernalia for its introduction. In hospital practice, however, its employment has undoubtedly aided materially in diminishing the fœtal mortality, and Thompson states that in 36 consecutive cases so treated in our service there was no maternal mortality.

The general practitioner is strongly warned against the employment of the vaginal pack or tamponade, except as a temporary expedient to check hemorrhage sufficiently to permit the transportation of the patient to a hospital. Even if sterile gauze is introduced under reasonably aseptic precautions, the pack is not devoid of danger, and definitely increases the probability of infection. Moreover, it affords a very uncertain means of controlling hemorrhage, as it usually merely checks the escape of blood from the vagina, but does not control its flow from the uterus.

At the time of labor the treatment depends primarily upon the general condition of the patient, and secondarily upon the degree of dilatation of the cervix. If the patient shows signs of shock, she should be immediately given a hypodermic of morphia, placed in a warm bed with its foot elevated, and transfused with 500 to 750 cubic centimeters of blood as soon as the necessary preparations can be made. Bill, of Cleveland, deserves great credit for having demonstrated the value of such prophylactic treatment, and he reportaed in 1927 a mortality of 1.78 per cent in a series of 56 patients so treated, as compared with 11.1 per cent in 45 cases treated without such precautions. Consequently, if the condition of the patient is at all serious, obstetrical treatment should be deferred until she has rallied following transfusion. Moreover, even if her condition is good, prospective donors should be secured so that transfusion can be promptly performed should subsequent necessity arise.

At the time of labor, the obstetrical treatment should vary according to the degree of dilatation of the cervix. If it is fully dilated, immediate delivery by version or forceps is indicated. On the other hand, if the dilatation is only partial, and the placenta is inserted marginally, good results very frequently follow artificial rupture of the membranes, since the placenta is then able to follow the retracting uterine wall. In all other cases, provided the child is alive, I prefer to complete the dilatation by means of a large Champetier de Ribes balloon, which should be introduced into the amniotic cavity after rupturing the membranes or perforating the placenta, as the case may be. Dilatation is hastened by gentle traction exerted by the hand or by a weight attached to the end of the tube, and after extrusion of the bag delivery is usually best effected by version and extraction. If, however, a balloon is not available, equally satisfactory maternal results may be obtained by Braxton Hicks's method of bipolar version, provided extraction is not attempted until the cervix is fully dilated.

The practitioner is earnestly warned against the employment of rapid manual or instrumental dilatation of the cervix. In this class of cases it is particularly prone to laceration, and, no matter how gradually and carefully the dilatation may be effected, deep tears frequently result. These may extend far out into the base of the broad ligament or up into the lower uterine segment, and occasionally entirely through the uterine wall. I recall one of my own cases in which death resulted from a large broad-ligament hematoma following a tear through the lower uterine segment, which I thought had been satisfactorily repaired, as well as several consultation cases in which laparotomy and amputation of the uterus were necessary to check intraperitoneal hemorrhage following rupture of the uterus resulting from extension of cervical tears.

As already indicated, all danger has not passed with the delivery of the child, and great care should be exercised in the conduct of the third stage of labor. If there is no hemorrhage, expression should not be attempted until the placenta has been expelled into the vagina; but if bleeding is profuse, Credé's method of expression should be immediately resorted to, and, if not effective, the placenta should be removed manually. If the loss of blood continues after the completion of the third stage, the cervix should be inspected, and immediately repaired if lacerated; but if no lesions are present, an intra-uterine pack should be introduced, so as to exert compression upon the flabby lower uterine segment. Even when the acute anemia has been treated before effecting delivery, it goes without saying that a second transfusion should be done and the usual methods for combating shock employed if the patient's condition is not satisfactory following the completion of labor.

In view of the danger to the mother, but particularly because many children are sacrificed by extraction through an imperfectly dilated cervix, Tait, Palmer Dudley, and others recommended the performance of cesarean section, provided the child is viable and the patient in good condition. Ten years later, in 1908, Krönig and Sellheim stated that 8 to 10 per cent of all placenta prævia patients die from hemorrhage, and held that our methods of treatment were in urgent need of improvement. Furthermore, as they believed that any method associated with natural or artificial dilatation of the lower uterine segment still further augmented the danger, they advocated that all cases of partial or central prævia should be treated by cesarean section, after which the lower uterine segment should be tightly packed with iodoform gauze. Their proposal has been accepted by many but has called forth severe criticism on the part of more conservative obstetricians and has given rise to a voluminous literature.

Doubtless in the hands of skilled operators a few more women and a good many more children may be saved by cesarean section, but that the difference is not very great is shown by Pankow, who reported a maternal mortality of 3.4 per cent following 58 sections as compared with 4.4 per cent in 76 cases treated conservatively. When these results are compared with those following conservative treatment, which were given in the section on prognosis, it becomes evident that the maternal results following section scarcely indicate any real improvement. It should also be remembered that good results will be obtained only in patients who have not been examined vaginally, and cannot be expected in neglected patients, who constitute so large a proportion of those admitted to a large obstetrical service. Furthermore, it should be borne in mind that even enthusiastic advocates of cesarean section advise that it should not be resorted to after the cervix has attained a diameter of 5 centimeters.

For these reasons, I believe that the skillful obstetrician will rarely resort to cesarean section except under two conditions—first, in the rare instances in which the cervix is too rigid to permit the introduction of a balloon, and second, in cases of complete placenta prævia in women nearing the end of the childbearing period, who are especially desirous of a living child. Furthermore, I am prepared to admit that cesarean section done by a competent general surgeon will give better results than obstetrical treatment in unskilled hands, but that is not ideal obstetrics. Thus far, very few cesarean sections have been done in our service for placenta prævia and, as the results following the employment of the balloon have been reasonably satisfactory, I do not anticipate extending greatly the employment of section.

The argument that wider use of cesarean section will increase the number of children born alive is plausible and attractive, but it should always be remembered that the majority of the children concerned are premature, so that even if they are delivered alive their chances for prolonged existence are not great. Consequently it seems the reverse of conservatism to expose the mothers to any additional risk on their account.

POSTPARTUM HEMORRHAGE

With the exception of the very rare cases incident to inversion of the uterus, a serious bleeding following the birth of the child is usually due to one of three causes. Of these the most common is defective functioning of the uterine musculature or atony; less frequently it is due to retention of the partially separated placenta or of individual cotyledons; while occasionally it results from deep tears involving the tissues of the birth canal. Fatal hemorrhage is fortunately rare, having occurred in 0.03 per cent, or once in 3121 times, in one million three hundred and odd labors studied by Stoeckel and Kermauner, in 1925.

Etiology.—As long as the placenta remains firmly attached to the uterine wall there can be no possibility of hemorrhage, but when it has become partially separated, the normal action of the uterine musculature is interfered with. As a result the torn vessels at the partially denuded placental site are imperfectly constricted, and more or less profuse hemorrhage occurs. Incomplete separation of the placenta may be attributed to improper management of the third stage of labor, particularly the too early and energetic employment of Credé's maneuver. Exceptionally, it may result from an abnormally intimate attachment of the placenta, due to defective development of the decidua, or some other morbid condition. The retention of isolated cotyledons or of a small succenturiate lobe interferes with the normal contraction and retraction of the uterus in precisely the same manner as the partially separated placenta.

The part played by deep tears of the generative tract is obvious, and will be considered in detail in the following chapter.

In very rare instances serious hemorrhage may result from rupture of large varicose veins, of an aneurysm of the uterine artery, or the disturbance of areas of thrombosis in the cervix.

Formerly, I held that atony of the puerperal uterus was a relatively infrequent cause of postpartum hemorrhage, but greater prolonged experience has convinced me that I was in error, and I now regard it as the most usual cause. This belief is based upon the fact that in most cases of moderate hemorrhage I have found no evidence of retention of placental tissue nor of tears, and the bleeding has persisted until vigorous contraction of the uterus was induced, when it ceased, never to return.

The cause of such defective functioning of the uterine musculature is not known, but the condition is seldom primary; for, with the exception of the instances in which it follows excessive distention of the uterus incident to twin pregnancy or hydramnios, serious abnormalities are usually associated with some mechanical cause, such as retention of portions of the placenta, the presence of myomata, or in rare cases the existence of adhesions between the uterus and the surrounding organs. Occasionally atony may be associated with degeneration of the muscle fibers resulting from an abnormal invasion of fœtal elements, as described by Kworostansky, Martin, and others. Moreover, the occasional instances in which patients bleed profusely after each labor without demonstrable cause likewise afford corroborative evidence of atony. In a number of such cases Labhardt believes that he has been able to demonstrate the presence of an excessive amount of connective tissue between and within the muscle bundles. In view of our experience, it is certain that Veit went too far in denying *in toto* the possibility of a primary atony.

Ujma, Küster and others state that prolonged malnutrition during the period of puberty may result in uteri which are so poorly developed that they fail to fulfill their function properly. Ujma reports that postpartum hemorrhage was ten times more frequent in Cologne, in 1928, than before the World War, and attributes it to changes following dietary privations incident to it. Kermauner holds that the term atony is incorrect, and that the condition giving rise to bleeding should be designated as "hypotonia." He is ignorant as to its cause, but suggests that latent infection or even histamine intoxication may be involved.

The rare cases of hemorrhage following *paralysis at the placental site,* in which the rest of the organ remains firmly contracted, as in the cases reported by Chiari, Braun and Spaeth, Olshausen, and others, point to the possibility of a partial atony.

Clinical History.—The loss of 600 or more cubic centimeters of blood was noted during and immediately following the third stage of labor in 13 per cent of 1000 consecutive normal labors which I have studied, while a loss of 1500 or more cubic centimeters was observed about once in every 100 labors. Bleeding to this extent occurred in 7918 patients in Stoeckel's series—0.8 per cent, and 3.5 per cent of them died. Excessive bleeding may supervene either during or shortly after the third stage of labor. In the first class of cases, as a rule, it is the result of tears or of partial separation of the placenta. Fortunately, hemorrhage dependent upon the latter cause is usually not serious, for the reason that it is only transitory, and ceases when complete separation has occurred. Exceptionally the bleeding may persist even after the placenta has become completely separated and lies free in the lower uterine segment or upper portion of the vagina. In such cases it is due either to tears or to imperfect functioning of the uterus.

Generally speaking, partial separation occurring during the course of placental expulsion by the Schultze mechanism is not accompanied by external hemorrhage until after the placenta has escaped from the vulva, when the large amount of blood collected behind it is suddenly discharged. In Duncan's mechanism, on the other hand, the loss of blood continues throughout the entire placental period.

A hemorrhage which persists after the extrusion of the placenta may be due to tears, retention of placental remnants, or to atony. In the first there is a steady flow of bright-red blood, which begins immediately after the delivery of the child. When due to retained placental tissue, the blood escapes in gushes, which are apt to be synchronous with the uterine contractions, and is frequently in large clots; whereas in cases due to primary atony there is a continuous flow of blood, which may be so abundant as to cause death within a very few minutes. In rare instances the hemorrhage may be *concealed,* several liters of blood sometimes accumulating in the uterine cavity.

The amount of blood lost during a postpartum hemorrhage may vary from 600 to 3500 cubic centimeters, the latter extreme, however, being invariably incompatible with life, although upon several occasions I have seen recovery follow a loss of 2500 cubic centimeters, and once after a measured loss of three liters. Generally speaking, the woman in labor can bear with comparative impunity the loss of an amount of blood which would seriously endanger the life of a well-developed man. This is due to the fact that a considerable increase in the amount of blood occurs during pregnancy. In any event, the effect of hemorrhage will depend more upon the general condition of the patient than upon the actual quantity lost. Thus, a woman who is already exhausted by a prolonged labor or weakened by antecedent disease may succumb after a loss of less than 1000 cubic centimeters, which others bear with impunity; but generally speaking the average woman can bear the loss of two liters without serious consequences. As a rule, the loss of a moderate amount of blood is not attended by serious symptoms; but when the hemorrhage is profuse the pulse becomes rapid and compressible, the face becomes pallid and assumes a drawn appearance, while at the same time the woman may complain of disturbed vision, chilliness, and shortness of breath. In extreme cases symptoms of air hunger appear, and the patient usually passes into unconsciousness before the fatal termination.

Diagnosis.—The diagnosis offers no difficulty, except in the rare instances in which the hemorrhage has taken place into the uterine cavity and does not appear externally. It must, however, be distinctly stated that concealed hemorrhage should never occur if the condition of the uterus is conscientiously watched, although, if routine precautions are neglected, the first indication of the condition may be afforded by the pale and haggard appearance of the patient. In such circumstances, the pulse rate will be found much accelerated, the uterus greatly increased in size, and presenting a doughy consistence, instead of the characteristic firm, hard sensation offered by the normal puerperal organ. Pressure upon it is followed by a copious flow of blood from the vagina.

As the decision concerning the proper treatment of the patient generally depends upon the recognition of the source of the hemorrhage, a differential diagnosis is of the utmost importance. Generally speaking, if the bleeding commences immediately after the birth of the child, it is due either to tears of the genital tract or to partial separation of the placenta. In the latter case it usually ceases temporarily after energetic kneading of the uterus, but recurs as soon as it is allowed to relax. If such manipulations prove of no avail, it is probable that the hemorrhage comes from a tear, although this is not a universal rule, since in a certain number of instances the loss of blood will continue until the placenta is expressed by Credé's method or is removed manually.

Again, a hemorrhage persisting after the uterus has been emptied, while abdominal palpation shows that the organ itself is firmly contracted, suggests an extensive tear of the birth canal, which should be sought for, and closed with sutures when found. In order to accomplish this, the patient having been brought to the edge of the bed, the external genitalia are carefully inspected. If the perineum is intact, the cervix should be forced down toward the vulva by pressure upon the fundus, and if this fails to bring it into view, it should be exposed by means of a speculum and tenaculum forceps. If a cervical lesion cannot be detected, the vaginal walls should be spread apart by means of a speculum and thoroughly inspected. A hemorrhage which does not come on until ten or fifteen minutes after the birth of the child can hardly be due to this cause.

On the other hand, if the uterus does not contract and retract firmly after the expulsion of the placenta, or if it remains so only so long as kneading is kept up, the cause of the hemorrhage must be sought for either in atony or in the retention of a placental cotyledon. Certainty with regard to the latter point is usually obtained by careful inspection of the after-birth, which should be made a matter of routine, a large defect upon its maternal surface indicating the retention of a cotyledon, while a more or less circular defect in the membranes a short distance from the placental margin shows that a succenturiate lobe has been left behind. At the same time one should be careful not to confound mere fissures with defects due to loss of tissue. The diagnosis of primary atony should be made only after every other explanation has been excluded.

Treatment.—With proper management, serious hemorrhage during and directly following the third stage of labor should be extremely rare. The most important prophylactic measures consist in watching the condition of the uterus after the birth of the child, and not resorting to Credé's maneuver until the rising up of the fundus indicates that the placenta has become completely detached. Premature attempts at expression are a frequent cause of imperfect separation. Again, owing to the tendency toward relaxation following the birth of twins, as well as in hydramnios, concealed hemorrhage, and placenta prævia, the condition of the uterus in such cases should be most carefully watched for the few minutes immediately following the birth of the child, and energetic kneading through the abdominal walls promptly resorted to upon the first sign of failing contraction.

If examination of the placenta immediately after its expulsion reveals any serious defect, immediate preparations should be made for the removal of the retained portion, whether symptoms supervene or not.

In the presence of actual hemorrhage, the treatment varies according as the placenta is still within the uterus or has already been expelled. In the former case the uterus should at once be grasped through the abdominal wall and firmly kneaded. If firm contractions come on, all is well, but if the hemorrhage continues and the uterus relaxes as soon as the kneading is stopped, the placenta should be expressed by Credé's method; and if this cannot be accomplished and the patient's condition is serious, it should be removed manually, when the directions given in Chapter XXIV should be conscientiously followed.

If the hemorrhage does not cease after the delivery of the placenta, the cause should be ascertained and suitable treatment instituted. Tears should be located and their edges brought together by sutures. On the other hand, if the hemorrhage is the result of the retention of placental tissue, the freshly gloved and disinfected hand should be carried up into the uterus in order to seek for and remove the retained cotyledon. In such circumstances the hand acts as a very efficient irritator, causing the uterus to contract energetically. After separating the retained portion of placenta, the hand should not be withdrawn at once, but should be allowed to recede gradually, as it is forced down by the contraction of the fundus.

If the hemorrhage is due to atony, the uterus should be vigorously kneaded, and 1 cubic centimeter of pituitary extract followed by 30 minims of the fluid-extract of ergot administered hypodermically. After careful disinfection of the skin, the needle should be plunged deep down into the tissues of the thigh, at right angles to the surface, since in this way the chances of abscess formation are greatly diminished. In my experience, pituitary extract acts within three minutes, but its effect is much more transient than that of ergot. Consequently, it is advisable to administer the former first, and to follow it by the latter if prolonged stimulation of the uterus is needed. When an even prompter response is essential, it may be secured by the intravenous administration of 0.5 cubic centimeter, as first recommended by Hofbauer.

Formerly, if these measures were not attended by the desired result, it was my practice to give a very hot intra-uterine douche of sterile salt solution, which usually acted as an efficient hemostatic, effectively irritating the uterus and causing it to contract forcibly and permanently. In recent years, however, I have abandoned it in favor of packing the uterus tightly with sterile gauze, applied through a Holmes' packer, as described in Chapter XXIV. This is done as soon as the patient has lost somewhat over 600 cubic centimeters of blood and her uterus tends to continue flabby in spite of pituitrin, and has given such satisfactory results that the necessary appliances are available at every delivery. Before resorting to the use of the pack it is always advisable to palpate the interior of the uterus, as occasionally a portion of the placenta may have been retained, even though immediately after expulsion the organ may have apparently been entire.

Fieux has pointed out that postpartum hemorrhage is usually venous in character and occurs under very low pressure. Accordingly he states that placing the patient in the Trendelenburg posture, which can be improvised by adjusting the back of a chair under the mattress, overcomes the pressure and checks the bleeding. I have had no experience with the method, but he states that its results are sometimes marvelous.

Should the loss of blood continue after the employment of these measures the aorta may be compressed by means of a stout rubber tube tied about the patient's waist, as recommended by Momburg. This emergency measure has been extensively employed in Germany, but has not found favor elsewhere.

Occasionally in postpartum hemorrhage due to atony following premature separation of the placenta, or placenta prævia, slow bleeding will persist in spite of all these measures. In such circumstances, if the patient is in a hospital, life may be saved by opening the abdomen and removing the uterus.

Formerly it was customary to recommend the introduction into the uterus of ice, or of solutions containing vinegar, the perchloride of iron, or other astringent substances. Their employment, however, is not advisable, since ice and ordinary vinegar are never sterile, while the iron solution accomplishes its purpose by the formation of dense coagula, which are later separated from the uterus by suppurative processes. Above all, none of them acts as promptly or efficiently as the pack, the employment of which, although comparatively rarely indicated, offers the most reliable means of coping with the condition. For this reason the obstetrician should always carry in his bag the materials necessary for it, as they cannot usually be obtained promptly in an emergency.

Too great stress cannot be laid upon the importance of observing the most rigorous aseptic technic in every intra-uterine manipulation undertaken for the purpose of checking postpartum hemorrhage. The natural tendency of the physician is to forget all other risks in his attempts to check the bleeding promptly. Such neglect, however, is frequently attended by most serious consequences, the patient being saved from death from hemorrhage merely to perish of infection a few days later. For this reason, therefore, the obstetrician will usually best subserve the interests of his patient by taking the time necessary for carefully disinfecting his hands, or at least for drawing on a fresh pair of sterile gloves, before beginning any manipulations. In view of the possibility of such emergencies, more than one pair of gloves should always be ready for instant use even in what promises to be the simplest case.

After the actual hemorrhage has been checked, attention must be directed to the general condition of the patient. When the shock is not profound and the pulse not particularly rapid, elevation of the foot of the bed and the application of hot water bottles to the extremities will be all that is needed. In more severe cases, the administration of 1/30 grain of strychnine hypodermically is useful, 3 doses being given in prompt succession, if necessary, and supplemented by hypodermic injections of whisky or ether. Hot rectal enemata of equal parts of black coffee and salt solution are also valuable.

When the patient is seriously shocked, sterile normal salt solution in large quantities—500 cubic centimeters being injected under each breast, and repeated as soon as absorption has occurred—will prove a useful temporary measure, while preparations for transfusion are being made; but as soon as they are completed, 500 to 750 cubic centimeters of blood should be administered. The results following it are sometimes marvelous, and I am confident that by this means I have saved several lives, which otherwise would have been lost.

INVERSION OF THE UTERUS

This condition is a very rare, but important, cause of postpartum hemorrhage. According to Beckmann, not a single case occurred in 250,000 labors in the St. Petersburg Lying-in Hospital, while McCullogh estimates that it occurs about once in 30,000 labors. Many obstetricians in large practice have never seen a case, or have met with only a few examples of the condition. On the other hand, it is much more frequently noted in the practice of ignorant midwives. The historical and statistical aspects of the subject are fully dealt with in the articles of Beckmann, Holmes, Vogel, and McCullogh.

Now and again the fundus of the uterus becomes inverted and comes into close contact with or may protrude through the external os; while in rare instances the entire organ appears outside of the vulva, the condition being respectively designated as *incomplete* and *complete inversion,* and *prolapse of the inverted uterus* (Fig. 715). In not a few cases the placenta remains attached to the inverted organ.

Etiology.—For the production of the accident three factors are necessary: marked laxity or thinness of the uterine walls, particularly at the placental site, pressure from above or traction on the cord or placenta, and a patulous cervical canal. Its occurrence is also favored by a fundal insertion of the placenta. Inversion may occur spontaneously as the result of the intra-abdominal pressure or from the mere weight of the intestines, but in most cases it is attributable to violence resulting from the too vigorous employment of Credé's maneuver or to traction upon the cord. In one of the cases which I saw in consultation it followed the manual removal of the placenta, while in two others it was due to too vigorous expression. Occasionally, inversion may recur in the same patient, Fritsch having observed it in three successive pregnancies.

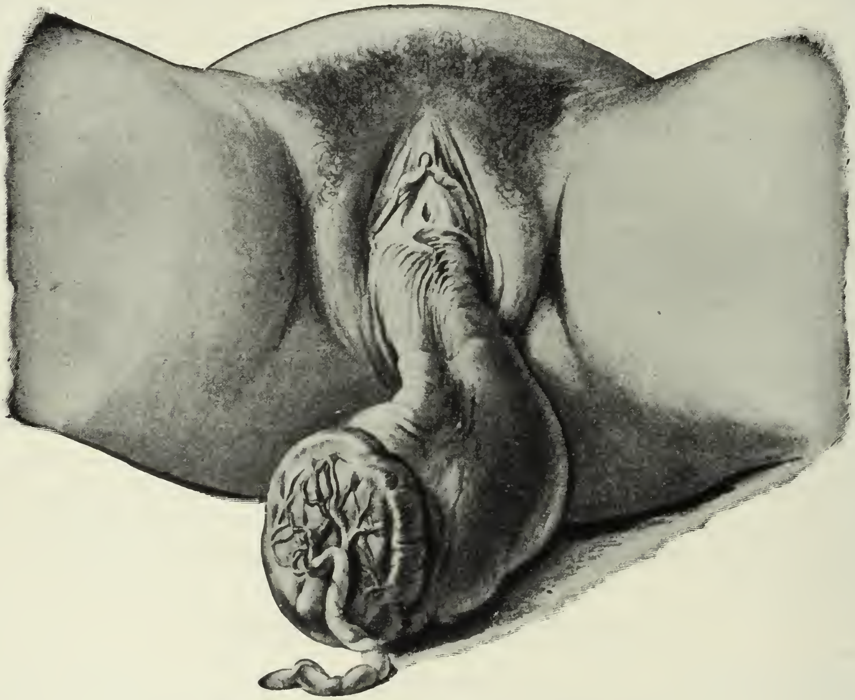


Fig. 715.—Prolapse of the Inverted Uterus (Bumm).

Beckmann, who has carefully analyzed 100 cases reported in the literature, believes that in the majority of instances the accident occurs spontaneously, while Vogel, in a similar review, holds that most cases are due to violence. His contention appears to be confirmed by Beckmann's statistics, as only 3 of the 100 cases occurred in hospital practice. Indeed, the accident is excessively rare when labor is properly conducted, but it occurs more frequently under the unfavorable conditions existing in private practice, particularly as conducted by midwives, McCullogh having collected 250 cases from the literature during the thirteen years preceding 1924.

The complication usually follows a full-term labor, although a number of cases are recorded in which it was noted after abortion. It is also an interesting fact that more than 50 per cent of the cases recorded by both Beckmann and Vogel were in primiparous women.

Symptoms.—As a rule, inversion of the uterus is promptly followed by alarming symptoms, the patient presenting evidences of shock out of proportion to the amount of blood lost, with a rapid pulse and a tendency to syncope. In other cases convulsions occur and profuse hemorrhage is frequently noted. On the other hand, the symptoms are sometimes very slight, and the condition may continue for several days without causing any serious annoyance to the patient.

In rare instances the cervix may so retract about the completely inverted uterus that strangulation occurs, followed by gangrene. In other cases this does not take place, but the condition becomes chronic, necessitating operative procedures later.

Prognosis.—If the condition is detected promptly, and the uterus replaced immediately, the prognosis is fair, Beckmann reporting a mortality of 14 per cent. On the other hand, if strangulation or gangrene occur, the outlook is ominous.

Treatment.—Immediately following inversion, reposition can usually be effected without difficulty by pressure exerted by several fingers in the vagina, it being important to remember that the force should be directed upward in the axis of the superior strait. Neglect of this precaution undoubtedly accounts for a certain number of failures. As the procedure is generally painful, anesthesia should be employed. On the other hand, if several hours have elapsed, reposition may be difficult or impossible. In this event, the patient is usually profoundly shocked, so that morphia should be given before beginning the anesthesia; while, if much blood has been lost, it may be advisable to wait until after she has been transfused.

If the placenta is still attached to the uterus, it is generally advisable to defer its separation until reposition has been effected, because, the contractile function of the inverted uterus being in abeyance, there is always the risk of profuse hemorrhage. That the shock is not necessarily the result of hemorrhage, is proven by the fact that it may develop in the absence of any excessive bleeding, and may disappear promptly following reposition.

If, however, the patient is not seen until several days after the accident, the cervix may have so contracted about the neck of the organ that reposition by manual manipulation is impossible, and radical interference becomes necessary. In such cases, unless the condition of the patient becomes precarious, it is wise to defer operation until later in the puerperium, although Palmer Findley has advocated prompt vaginal hysterectomy. Particulars concerning the operative technic for the relief of chronic inversion will be found in the current works on gynecology.

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CHAPTER XLI

INJURIES TO THE BIRTH CANAL

INJURIES TO THE VULVAL OUTLET

In the chapter upon the Conduct of Normal Labor reference was made to the frequency of perineal lacerations, and emphasis was laid upon the necessity for repairing them immediately after the birth of the child.

More rarely tears occur about the anterior portion of the vulva. In spontaneous labor these seldom amount to more than slight abrasions upon the inner surfaces of the labia minora, but in forceps deliveries, especially when the handles have been unduly elevated, serious lesions may follow the compression of the tissues between the pubic arch and the blades of the instrument. Now and again the labia minora are completely severed or torn loose from their connections, or deep tears occur on either side of the urethra implicating the vessels supplying the clitoris and giving rise to profuse hemorrhage; while following pubiotomy, such tears may communicate with the pubic wound.

INJURIES TO THE VAGINA

With the exception of the most superficial varieties, which are limited to the mucous membrane of the fourchette, all perineal lacerations are accompanied by more or less injury to the lower portion of the vagina. Such tears rarely occur in the median line, but extend a variable distance up one or both vaginal sulci, being sufficiently deep to involve some fibers of the levator ani muscle. Bilateral lacerations of this variety are usually unequal in length and are separated from one another by a tongue-shaped portion of mucosa which represents the lower end of the posterior column of the vagina (Fig. 335).

These injuries should always be looked for, and their repair should form a part of every operation for the restoration of a lacerated perineum. If this precaution is neglected and the external wound alone is sutured, the patient will eventually present symptoms due to *relaxation of the vaginal outlet,* even though the perineum proper may be in perfect condition.

Isolated tears involving the middle or upper third of the vagina, and unassociated with lacerations of the perineum or cervix, are very rarely observed. They are usually longitudinal, and result from injuries sustained during a forceps operation, though now and again they follow spontaneous delivery. They frequently extend deeply into the underlying tissues and may give rise to a copious hemorrhage, which, however, is readily controlled by a few sutures. Their presence is readily overlooked, inasmuch as they can be recognized only after the vaginal walls have been spread apart by means of a speculum.

More important are the *injuries to the levator ani muscles,* which are not associated with tears through the vaginal mucosa, and which consequently usually escape immediate detection. As a result of overdistention of the birth canal, there may occur a submucous separation of certain fibers of the muscle, or at least so great a diminution in its tonicity, that it can no longer properly fulfill its function as the pelvic diaphragm. In such cases the patient sooner or later suffers just as severely from symptoms of relaxation as if a deeply lacerated perineum had been left unrepaired. Although the accident can sometimes be avoided by an intelligent use of forceps when the second stage of labor is unduly prolonged, it frequently follows spontaneous and rapid delivery.

Lesions of the upper third of the vagina are extremely uncommon, unless they represent the extension of deep cervical tears into the fornix. In very rare instances, however, the cervix may be entirely or partially torn loose from its vaginal attachment, rupture in other cases occurring in either the anterior, posterior, or lateral fornix. Hugenberger, in 1875, collected 40 cases of this accident from the literature, and designated it as *colpaporrhexis;* while Gamble has made an extensive survey of the literature up to 1927.

The accident is somewhat analogous to rupture of the lower uterine segment, and follows energetic efforts on the part of the uterus to overcome some obstacle to the passage of the child. In Gamble's patient it was due to overstretching of the posterior fornix incident to an unusually pendulous abdomen. As a result of the retraction of Bandl's ring, so great a strain may be exerted upon the cervix that it is torn loose from its vaginal attachment. It is commonly taught that colpaporrhexis is possible only in those cases in which the lips of the cervix are not compressed between the presenting part and the pelvic wall, but are free to follow the retracting uterus. While colpaporrhexis sometimes occurs spontaneously, it more frequently follows brutal and unskillful use of forceps.

The symptoms are identical with those following rupture of the uterus, and will be considered under that heading. Immediately following the rupture, the child may escape into the peritoneal cavity, after which the intestines may protrude into the vaginal canal, as in a case reported by Ross.

The diagnosis is made solely by the sense of touch, as the clinical symptoms do not differ from those following rupture of the uterus. The prognosis is extremely unfavorable, a large proportion of the cases reported in the literature having ended fatally.

Most authorities recommend treating the condition by means of a vaginal pack, a procedure which probably explains in part the high mortality. I, however, agree with Schick that laparotomy offers the best chance for successfully coping with this emergency, since in that way one can obtain an accurate idea of the extent of the injury, when the torn surfaces may be united by sutures, or failing that, the uterus may be removed.

LESIONS OF THE CERVIX

Slight degrees of cervical laceration must be regarded as an inevitable accompaniment of childbirth. Such tears, however, heal rapidly and rarely give rise to symptoms. In healing they cause a material change in the shape of the external os, and thereby afford a means of determining whether a woman has borne children or not.

In other cases the tears are deeper, implicating one or both sides of the cervix and may extend up to or beyond the vaginal junction. In rarer instances the laceration may extend across the vaginal fornix or into the lower uterine segment, and occasionally open up the base of the broad ligament. Such extensive lesions frequently involve vessels of considerable size, and are then associated with profuse hemorrhage.

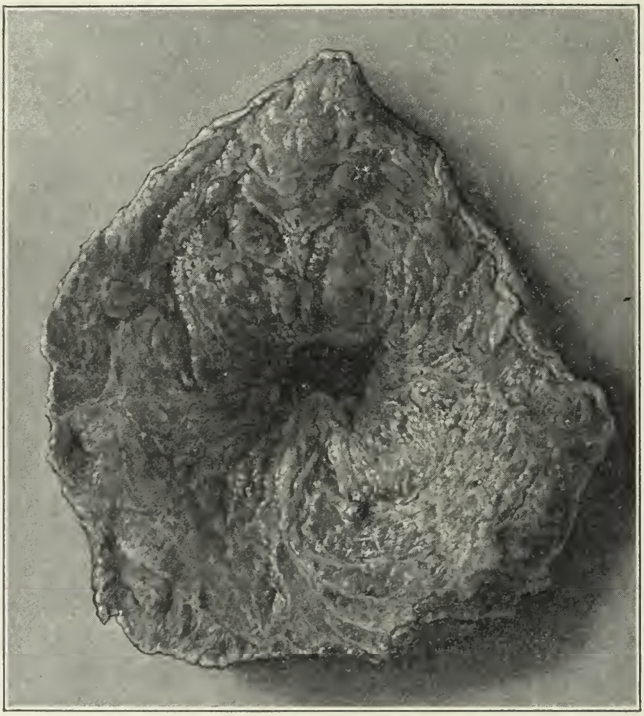

Fig. 716.—Annular Detachment of Cervix.
Specimen cast off before the birth of child, showing undilated and rigid external os and obliterated cervical canal seen from within. × 1.

Deep cervical tears occasionally occur during the course of spontaneous labor, and under such circumstances their genesis is not always clear. More usually, however, they follow rapid manual or instrumental dilatation, especially in eclampsia, placenta prævia, or in the various types of cervical dystocia. Moreover, they are apt to result from attempts at delivery through an imperfectly dilated cervix, no matter whether forceps or version be employed.

Occasionally, even in spontaneous labors, the edematous anterior lip of the cervix may be caught between the head and the symphysis pubis and be compressed until it undergoes necrotic changes and separation occurs. In still rarer instances the entire vaginal portion may be torn loose from the rest of the cervix, and be cast off. According to Boudreau, this so-called annular or *circular detachment of the cervix* usually occurs in elderly primiparæ when the pains are strong and a serious obstacle to delivery is offered by an imperfectly dilated os externum.

Symptoms.—In all lesions involving the cervix there is usually no escape of blood until after the birth of the child, when the hemorrhage may be profuse. In many cases, however, the bleeding is so slight that the condition would pass unrecognized were it not detected upon vaginal examination. When one lip of the vaginal portion of the cervix is torn off, there is usually very little hemorrhage, for the reason that the tissues have been so compressed before the occurrence of the accident that the vessels have undergone thrombosis. Likewise, in our case of circular detachment of the cervix, figured on the preceding page, there was no bleeding, and the nature of the cast-off tissue was not recognized until after examination in the laboratory.

Slight cervical tears heal spontaneously, and extensive lacerations have a similar tendency, but perfect union rarely results. They afford to any pathogenic micro-organisms which may be present a ready portal of entry into the lymphatics at the base of the broad ligament.

The development of erosions at the site of the old tears is frequently the cause of persistent leukorrhea. Consequently, at the end of the puerperium, it is advisable as a matter of routine to examine the cervix by means of a speculum, and if such areas are found to cauterize them as a prophylactic precaution.

Diagnosis.—A deep cervical tear should always be suspected in cases of profuse hemorrhage coming on during the third stage of labor, if the hand applied over the lower abdomen feels that the uterus is firmly contracted. For a positive diagnosis, however, a thorough examination is necessary. Owing to the flabby condition of the cervix immediately after delivery mere digital examination is often unsatisfactory, and the extent of the injury can be fully appreciated only after drawing the cervix down to the vulva and carefully subjecting it to direct inspection.

In view of the frequency with which deep tears follow operative procedures, the cervix in all such cases should be inspected as a matter of routine at the conclusion of the third stage, even if there be no bleeding; and if a tear is discovered, it should be united by sutures as a prophylactic measure. Annular detachment of the vaginal portion of the cervix should be diagnosticated whenever an irregular mass of tissue having a circular opening in its center is cast off before or after the birth of the child.

Treatment.—Deep cervical tears accompanied by hemorrhage should be immediately repaired, the introduction of a few sutures readily checking the flow of blood. On the other hand, if there be no hemorrhage, the condition usually escapes detection unless specifically looked for. I have already indicated the advisability of inspecting the cervix after all operative procedures; but I consider its routine employment unnecessary after normal labor, in the first place, because satisfactory exposure is difficult with the patient in bed; and, secondly, because I believe that the benefits following the repair of all tears will be more than counterbalanced by the increased incidence of infection resulting from the necessary manipulations. Moreover, the majority of such tears heal spontaneously, and in the exceptional cases in which this does not occur better results are obtained by a secondary operation performed in the latter part of the puerperium.

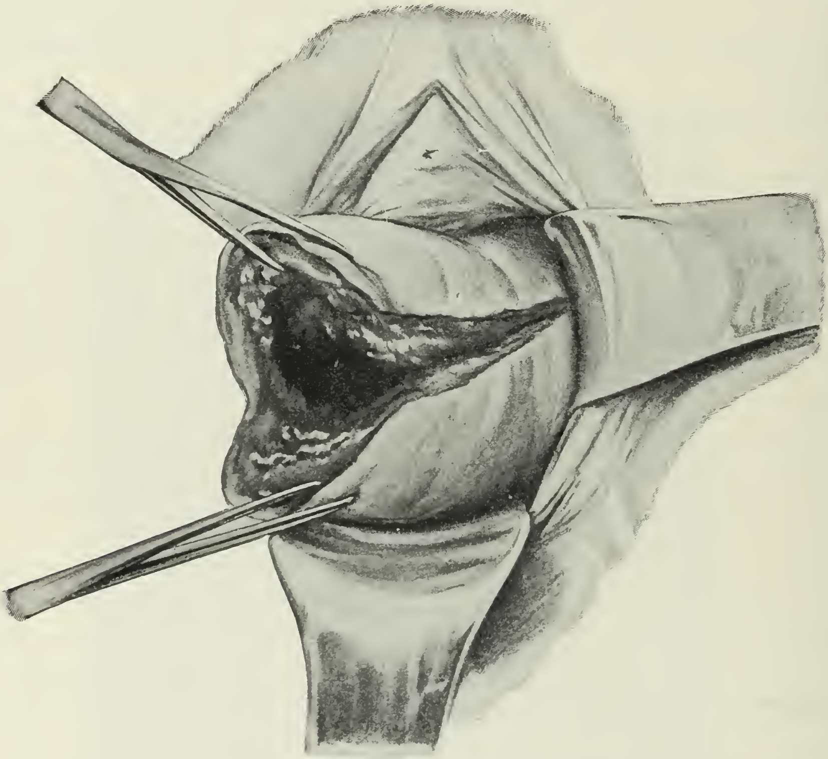

Fig. 717.—Lacerated Cervix Drawn Down to Vulva, Preparatory to Repair (Bumm).

The treatment of cervical tears associated with hemorrhage varies with the extent of the lesion. When the laceration is limited to the cervix, or even when it extends well into the vaginal fornix, satisfactory results are obtained by the introduction of sutures after bringing the cervix into view at the vulva. This is effected by having an assistant make firm downward pressure upon the uterus, while at the same time the operator exerts strong traction by means of a fenestrated ovum or sponge forceps applied to either lip of the cervix, the vaginal walls being held apart by means of suitable retractors (Fig. 717). As the hemorrhage usually comes from the upper angle of the wound, it is advisable to apply the first suture in that situation, since if the suturing is begun at the free end of the tear a dead space is often left toward its upper extremity, from which subsequent hemorrhage may occur. Interrupted chromicized catgut sutures should be employed, as they do not have to be removed. The beginner is cautioned against too great a regard for appearances and attempting to give the cervix too normal a look, inasmuch as the retraction occurring within the next few days may lead to such constriction of its lumen as to cause retention of the lochial discharge.

Many authorities recommend a tight vaginal pack in this class of cases. No doubt, it will usually check the hemorrhage and may be employed in an emergency, but it does not compare in efficiency with repair by suture. In the rare cases in which the wound extends through the broad ligament into the peritoneal cavity a tight pack may be introduced, provided there is no serious hemorrhage; but in all other cases the only satisfactory method of dealing with the condition is by laparotomy.

The treatment of tears of the upper part of the cervix which involve the lower uterine segment will be considered in the following section.

RUPTURE OF THE UTERUS

This accident, which is one of the most serious with which the obstetrician can be confronted, seldom occurs except in prolonged and obstructive labors, although instances of spontaneous rupture during pregnancy are not unknown.

While spontaneous rupture occurs more frequently in the last months, it may be met with at any period of pregnancy. Thus, 31 out of 78 cases collected by Baisch were observed during the first five months of pregnancy. In the first half of gestation the accident is usually due to pregnancy in the interstitial portion of the tube or in a bicornuate or infantile uterus, or to excessive invasion of the uterine wall by fœtal elements. In the latter months the condition is usually associated with the presence of scar tissue in the uterine wall, which yields gradually with the increasing distention of the organ. Accordingly it occurs in 1 or 2 per cent of women who had previously been subjected to cesarean section, or in women whose uteri had been previously perforated or otherwise injured during curettage or some other operative procedure. Very exceptionally the accident may be attributed to lack of hypertrophy of the uterine wall at the fundal region; while Poroschin considers that it may be due to the relative absence of elastic tissue. Jellinghaus and others are inclined to attribute certain cases to inherent weakness of the uterine walls resulting from the excessive formation of connective tissue following the removal of an adherent placenta in previous pregnancies, as in the cases collected by Riddell. Schäfer has reported a case due to diffuse adenomyometritis, and has collected the literature up to 1918.

In spontaneous rupture occurring during pregnancy, the lesion is almost invariably situated in the upper portion of the uterus. This is in marked contrast to the conditions observed at the time of labor, when the rupture is usually limited to the lower segment, and clearly indicates that radically different etiological factors must be concerned. Contrary to the statement of Blind that the rupture nearly always occurs in the neighborhood of the fundus, Baisch found that it was situated upon the anterior or posterior wall in 32 out of 56 cases in which the location of the rupture had been accurately described.

The symptoms, diagnosis, prognosis, and treatment of this condition are identical with those following rupture of the uterus occurring at the time of labor. It should be noted, however, that in a number of the cases reported in the literature the hemorrhage following the accident was so slight as not to give rise to symptoms, the condition escaping recognition until operative procedures became necessary for the removal of the fœtus lying free in the abdominal cavity.

In very exceptional instances, as in the cases reported by Leopold and Henrotin, the placenta remained in the uterus, while the fœtus, surrounded by its membranes, escaped into the peritoneal cavity, where it went on to further development—*utero-abdominal pregnancy*. Such an occurrence is very unusual, as escape into the peritoneal cavity is ordinarily synonymous with fœtal death.

Etiology.—According to Asa B. Davis, rupture of the uterus, excluding those due to the giving way of a cesarean scar, was noted 184 times in a series of 147,625 deliveries at the New York Lying-In Hospital—an incidence of 1 to 810. It is a most serious complication, as it nearly always leads to the death of the fœtus, and frequently to that of the mother as well.

We are indebted to Bandl for the first clear explanation as to its mode of production, its etiology being inseparably connected with the doctrine of the lower uterine segment and the formation of the contraction ring.

Normally, under the influence of labor pains the uterus becomes differentiated into two portions, separated by a circular ridge of tissue, to which the term *contraction ring* is usually applied. The upper, by its contractions, serves to expel the child, while the lower undergoes dilatation and passively forms part of the canal through which the contents of the uterus are expelled. On the other hand, when a serious obstacle is opposed to the passage of the child, the active portion of the uterus is stimulated to more forcible efforts. As it contracts it likewise slowly becomes retracted, its lower margin—the contraction ring—eventually occupying a much higher level than usual. As a result, particularly if the lips of the cervix are caught between the presenting part and the superior strait, powerful upward traction is exerted upon the passive lower segment of the uterus, which becomes more and more stretched, and thinner and thinner. At the same time the contraction ring separating the two portions becomes thicker and more prominent, so that it can readily be palpated, and occasionally seen as a transverse or oblique ridge extending across the abdomen just below or perhaps on a level with the umbilicus. The round ligaments, likewise, are subjected to an abnormal strain and remain tense even in the intervals between the uterine contractions.

As the process goes on the lower segment becomes extremely sensitive to pressure, and the contractions increase progressively in frequency and intensity, until eventually the upper segment of the uterus passes into a tetanic condition, and no longer alternates between contraction and relaxation. At the same time the contraction ring becomes more prominent on palpation. The pulse becomes more rapid, and as a result of the increased suffering the patient presents a worn and haggard appearance. Such a condition indicates that rupture is imminent and will occur unless delivery is promptly effected in a conservative manner.

Generally speaking, rupture is more apt to take place when one side of the lower uterine segment is subjected to greater stretching than the other. In transverse presentations this condition is most marked on the side of the uterus occupied by the head. A similar danger threatens the posterior wall when the child presents by the head and the patient has a markedly pendulous abdomen.

Excessive stretching of the lower uterine segment, with consequent danger of spontaneous rupture, is favored by any factor which interferes with the birth of the child, and more particularly with the entrance of the presenting part into the pelvis. Such conditions are most frequently afforded by contracted pelves, neglected transverse presentations, impacted ovarian cysts, hydrocephalus, excessive size of the child, and, in fact, by any obstacle to labor. In recent years, the injudicious use of pituitary extract in cases of disproportion has resulted in the production of many uterine ruptures, which are frequently accompanied by unusually extensive injury. The following analysis by Merz shows the etiological factors concerned in the production of 160 cases of rupture of the uterus:

	Cases
Contracted pelvis	70
Neglected tranverse presentation	26
Hydrocephalus	18
Large child or unfavorable presentation	10
Stenosis of birth canal	6
Trauma	5
Pelvic Tumor	3
Ascites	1
Operative procedures	21

It is generally held that excessive stretching of the lower uterine segment can occur only after a prolonged second stage, but Goldner, in 1903, reported 19 instances in which rupture appeared imminent before the escape of the amniotic fluid. In these cases the condition was associated with oligohydramnios, very resistant membranes, or a rigid cervix.

It is customary to distinguish between *spontaneous* and *traumatic rupture* of the uterus. In the former the accident occurs spontaneously, while in the latter, it is the result of ill-judged manipulations on the part of the obstetrician in a uterus whose lower segment is so thinned out and distended that the slightest violence proves too much for its resisting powers. In other cases it may result from the upward extension of cervical tears, following rapid manual or instrumental dilatation of the cervix.

Traumatic rupture occurs relatively frequently when version is attempted in neglected transverse presentations. The proper treatment of this complication requires the utmost nicety of judgment, as it is ofttimes extremely difficult to determine whether the lower uterine segment is so thinned out as to contraindicate such attempts, the operation being sometimes readily accomplished under anesthesia in cases in which, at first sight, it had appeared impracticable; whereas, in others, in which it seemed that the necessary manipulations would be without danger, rupture follows the mere introduction of the hand. Moreover, there is a marked difference in the rapidity with which overstretching of the lower uterine segment comes about, the condition supervening very rapidly in some cases, while in others many hours of strong, second-stage pains may be necessary for its production.

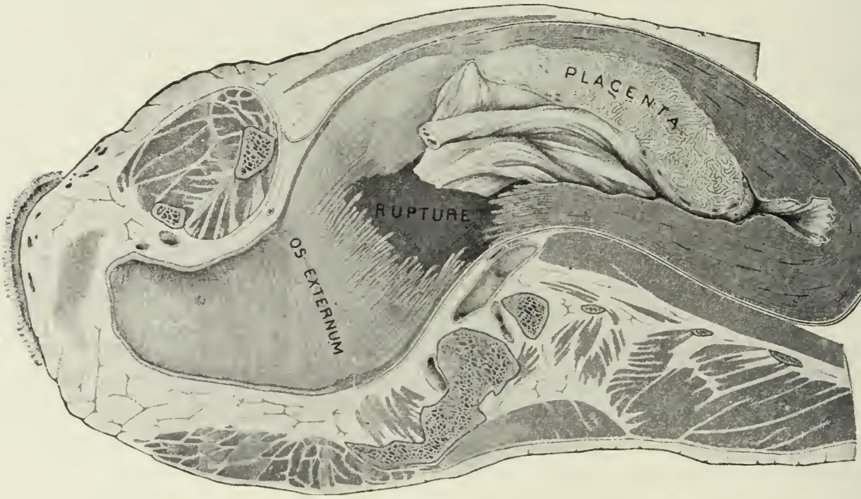

Fig. 718.—Longitudinal Section through Woman Dying from Rupture of the Uterus (Zweifel).

Certain women seem to possess a predisposition toward rupture of the uterus, this assumption being supported by the fact that not a few cases of repeated rupture appear in the literature. Thus, Mikhine found records of 13 patients, 6 of whom died as a result of a second rupture, the latter occurring in tissues already weakened by the previous accident.

Pathology.—Spontaneous rupture of the uterus occurring at the time of labor is limited almost entirely to the lower uterine segment, the rent usually pursuing an oblique direction; although when it is in the immediate vicinity of the cervix it frequently extends transversely. On the other hand, it is usually longitudinal when it occurs in the portion of the uterus adjacent to the broad ligament, and according to Freund, when it occurs spontaneously in neglected transverse presentations.

It is customary to distinguish between *complete* and *incomplete rupture*, according as the laceration communicates directly with the abdominal cavity or is separated from it by the peritoneal covering of the uterus or broad ligament. The former is the more common, Merz having collected 118 complete as against 46 incomplete ruptures. Of 106 ruptures occurring at the New York Lying-In Hospital. Davis states that 64 were complete, 18 incomplete, and 24 following cesarean section, with a mortality of 69.44 and 12.5 per cent, respectively.

Incomplete ruptures frequently extend into the broad ligament; in such circumstances the hemorrhage often occurs less rapidly than in the complete variety, the blood slowly accumulating between the leaflets and leading to the separation of the peritoneum from the surrounding viscera, with the consequent formation of a large *subperitoneal hematoma*. Occasionally, an effusion of blood sufficiently copious to cause the death of the patient may be inclosed in such a structure. More frequently, however, the fatal issue does not occur until secondary rupture of the hematoma relieves the pressure which had previously, to some extent, restrained the bleeding, and permits the blood to escape into the peritoneal cavity.

Although occurring primarily in the lower uterine segment, it is not unusual for the laceration to extend further upward into the body of the uterus or downward through the cervix into the vagina. The tear itself usually presents jagged, irregular margins which are stained with blood.

Following complete rupture, the uterine contents may escape into the peritoneal cavity, but, when the presenting part is firmly engaged, only a portion of the fœtus may escape, the rest remaining in the uterine cavity. On the other hand, in the incomplete variety, the product of conception may remain within the uterus, or come to lie beneath the serous covering of the uterus or between the leaflets of the broad ligament.

Symptoms.—The symptoms of actual rupture vary considerably. During the latter months of pregnancy, whether it occurs spontaneously or as the result of traumatism, the patient usually experiences sharp abdominal pain. In some cases symptoms of collapse immediately supervene, but in many instances the patient merely complains of malaise, grave symptoms only occurring later as the result of infection or of putrefaction of the fœtus. Thus, in one of my cases, two weeks elapsed before the appearance of alarming symptoms; while in another, in which the scar of a previous cesarean section had given way and the entire product of conception had been expelled into the peritoneal cavity, the patient walked to the dispensary the day after the accident, and presented a pulse of only 80 when placed upon the operating table. In the earlier months, on the other hand, profuse hemorrhage is the rule, and the patient rapidly succumbs to acute anemia if not operated upon.

If the accident occurs at the time of labor, the patient, after presenting for some time the premonitory signs of the accident, suddenly, at the height of an intense uterine contraction or during an intra-uterine manipulation, complains of a sharp, shooting pain in the lower abdomen, and frequently cries out that something has given way inside of her. On several occasions, I have heard a distinct click when the rupture occurred. At the same time the lower uterine segment becomes much more sensitive to pressure. Immediately following these symptoms there is an absolute cessation of the uterine contractions, and the patient, who had previously been in intense agony, suddenly experiences great relief. At the same time there is usually some external hemorrhage, although in many cases it is very slight in amount.

Palpation or vaginal examination shows that the presenting part has slipped away from the superior strait and has become movable, while a hard, round body, which represents the firmly contracted uterus, can be felt alongside of the fœtus. Naturally, if the uterine contents have escaped into the abdominal cavity, the presenting part cannot be felt on vaginal examination.

As a rule, shortly after the occurrence of complete rupture, the patient presents symptoms of collapse, the pulse increases in rapidity, loses tone, and takes on a filiform character, the face becomes pallid, assumes a drawn appearance, and is often covered with beads of sweat. If the hemorrhage has been copious, she may complain of chilliness, disturbances of vision, and air hunger, and eventually pass into an unconscious state. Symptoms of collapse, however, do not always appear immediately, but are sometimes deferred for several hours after rupture, being less marked when the child remains partially within the uterus. After incomplete rupture, on the other hand, the immediate symptoms are sometimes very slight, but increase in severity as the subperitoneal hematoma becomes larger. Occasionally, the condition of the patient does not appear serious until symptoms of peritonitis appear.

Occasionally after incomplete rupture, emphysematous crackling can be elicited in the tissues of the anterior abdominal wall, 14 cases of this character having been collected by Dischler. It is probably due to the invasion of the subperitoneal connective tissue by Bacillus aërogenes capsulatus. It is true that bacteriological proof has not been adduced in support of this statement, but the fact that the women had been in labor for many hours, and that many of the children were more or less putrefied, speaks in favor of such a view.

Diagnosis.—In cases of spontaneous rupture during pregnancy the diagnosis is not always easy. If the collapse is profound, it should at once lead to a provisional diagnosis of intra-abdominal hemorrhage, but in other cases the condition may escape detection until the appearance of peritonitic symptoms. Generally speaking, it may be said that a rapid pulse, slight elevation of temperature, and abdominal distention associated with very distinct palpation of the fœtus, should always be regarded with grave suspicion, particularly when preceded by a history of traumatism.

On the other hand, the diagnosis is usually easy when the accident occurs at the time of labor, especially if the patient has been under supervision during its course. If she is not seen until later the characteristic history and the collapse are almost pathognomonic, the only other conditions in which the latter is noted before delivery being in cases of rupture of an advanced extra-uterine pregnancy, or of the premature separation of the normally implanted placenta.

If the child has escaped into the abdominal cavity it is much more readily felt on palpation than usual, while on one side of it the hard, rounded body of the uterus can be detected. Moreover, vaginal examination sometimes reveals the existence of a tear in the uterine wall through which the fingers can be passed into the abdominal cavity, where they come in contact with the intestines, although failure to detect the tear by no means indicates its absence. Again, the fact that the presenting part, which was previously engaged in the superior strait, can no longer be felt is conclusive evidence that the fœtus has escaped from the uterus.

Prognosis.—The chances for the child are almost uniformly bad. On the other hand, if it has survived up to the time of the accident, its only chance of living is afforded by immediate extraction, asphyxia, the result of the separation of the placenta, being otherwise inevitable. If left to themselves, the vast majority of the mothers die from hemorrhage or infection, although spontaneous recovery has been noted in exceptional cases. In the 23 cases reported by Scipiades, which came to autopsy, death was due to infection in 52 per cent, and the remaining 48 per cent to hemorrhage or shock.

Death from hemorrhage usually occurs within the first few hours, though occasionally it may be deferred for forty-eight hours; in infection the fatal termination may not occur for some days.

Spontaneous recovery is least likely when the child has escaped into the abdominal cavity, though isolated instances are on record in which the patient has survived even such an accident. In such circumstances the child is usually surrounded by fœtal membranes, and after its death may undergo any one of the several eventualities mentioned in the chapter on Extra-uterine Pregnancy. So far as the women are concerned, even if properly treated, the mortality is very high, at least one-third succumbing.

Treatment.—(*a*) *Prophylactic.*—Intelligent care of the lying-in woman should almost entirely do away with this accident. Accordingly, it occurs very rarely in well-regulated hospitals and comparatively frequently in the homes of the poor—in Scipiades' series of 91 cases the respective incidence was 0.046 and 0.53 per cent. Whenever there is a possibility of the existence of an obstacle to the birth of the child, the obstetrician should always be on the alert for symptoms indicative of impending rupture. Transverse presentations should be promptly delivered by version as soon as the cervix is fully dilated; in head presentations failure of engagement after one hour of strong second-stage pains should be regarded with suspicion, and, if the contraction ring rises up, labor should be promptly terminated by the most conservative procedure. In neglected cases, decapitation in transverse and craniotomy in head presentations often promise the best results. Such procedures are the more justifiable in the circumstances, as the children are usually either already dead or have been exposed to such damage that their chances of being delivered alive are very slight.

(*b*) *Curative.*—If the child is alive and still within the ruptured uterus, or if it has already escaped into the abdominal cavity, no attempt should be made to extract it *per vaginam,* but laparotomy should be immediately performed, and followed, after removal of the child, by whatever operative procedures may be deemed necessary—suture of the tear, supravaginal amputation, or total removal of the uterus.

On the other hand, if the child is dead and still within the uterus, certain authorities recommend its delivery through the natural passages by the most feasible and conservative procedure, after which, as well as in those cases which are not seen until after delivery *per vaginam* or in which the uterine rupture was not recognized until later, various procedures have been suggested by different authorities. I do not advocate delivering the child through the natural passages in any case, but I would especially warn against any attempt to do so after it had escaped into the peritoneal cavity, as the necessary manipulations will inevitably add to the shock from which the patient is suffering, and lead to an increase in the size of the tear and render its repair more difficult when the abdomen is opened.

I believe that in hospital practice the best results will follow laparotomy, no matter what the character of the tear or the extent of the hemorrhage; for the reason that it is often difficult to determine the extent of the laceration, and furthermore that it is impossible to foretell whether the hemorrhage can be controlled by simple procedures. I therefore agree with Fritsch, Varnier, Zweifel, and Munro Kerr, who hold that it is only by opening the abdomen that one can be assured against all further risk of hemorrhage. In general, the best results are obtained by amputating the uterus. At first glance it would appear very simple to repair the rent by sutures, and thus preserve the organ. But in practice it is not so simple, for in many instances the wound conditions are so complicated and the edges of the rent so damaged by hemorrhage and trauma, that accurate coaptation by means of sutures is out of the question. Furthermore, the fact that the patient has probably already been infected would contra-indicate any attempt to conserve the damaged tissues. On the other hand, if the patient cannot be removed to a hospital, and expert surgical aid is not available, one must be content with the employment of palliative measures after having delivered the child and placenta through the natural passages. In such circumstances, the results are usually disastrous following complete rupture, but are sometimes surprisingly good in the incomplete variety.

Many authorities contend that, inasmuch as the danger to be apprehended in cases of incomplete rupture is hemorrhage, laparotomy should be performed only when the loss of blood is profuse, but that in all other cases equally good, if not better, results may be obtained by draining or packing the rupture from the vagina. Schmit, Klien, Scipiades, and others have collected large series of cases which apparently bear out this contention.

My own experience, however, leads me to believe it irrational to adopt such procedures as a matter of choice, as occasionally women who are apparently in excellent condition shortly after the occurrence of the rupture may begin to bleed profusely some hours later, and may die before operative measures can be instituted. Furthermore, I do not believe that the statistical evidence thus far adduced gives a correct idea of the relative merits of the two methods of treatment, for the reason that packing is usually employed in the milder and more favorable cases, whereas radical surgical measures have been practically limited to the desperate cases.

INSTRUMENTAL PERFORATION OF THE UTERUS

Reference has already been made to perforation of the uterus following attempts at criminal abortion or in the effort to remove placental tissue by means of curet or polypus forceps, after an incomplete abortion. Similar accidents likewise occasionally occur as the result of want of skill on the part of the obstetrician in full-term labor, when either the uterus or the vaginal vault may be perforated. As has already been pointed out, in cases of this character, loops of intestine frequently prolapse through the rupture. In such circumstances laparotomy is the ideal treatment, though, in the absence of prolapse of the intestines, cases are recorded in which recovery occurred spontaneously under what were apparently most unfavorable circumstances.

A graphic idea of the variety and extent of such injuries is afforded by the illustrations in Liepmann's book on criminal abortion, while the literature up to 1926 is critically considered in the monograph of Peham and Katz.

PERFORATION OF THE GENITAL TRACT FOLLOWING NECROSIS

In the obstructed labor the tissues in various portions of the genital tract may be forcibly compressed between the head and the bony canal. If the pressure is transitory it is without significance; but if it is long continued necrosis results, and after a few days the area implicated sloughs away so that perforation follows.

In most cases of this character the perforation occurs between the vagina and the bladder, giving rise to a *vesicovaginal fistula*. Less frequently the anterior lip of the cervix is compressed against the symphysis pubis, and an abnormal communication is eventually established between the cervical canal and the bladder—*cervicovesical fistula*.

If the patient is not infected the fistulous tract frequently heals without further treatment. In other cases, however, it may persist, when a subsequent plastic operation becomes necessary for its cure.

Occasionally the posterior wall of the uterus may be subjected to so much pressure against the promontory of the sacrum that necrosis results, and a connection is established with Douglas' culdesac. If infection occurs the accident is usually followed by septic peritonitis. Fortunately, recovery usually follows without further complications, inasmuch as a localized peritonitis leads to the formation of adhesions between the posterior wall of the uterus and the pelvic peritoneum, thereby doing away with the possibility of a general peritoneal infection. It should be remembered that similar lesions may occur in the rare cases in which exostoses or bony spicules protrude from the walls of the birth canal, as in *pelvis spinosa.*

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CHAPTER XLII

PROLAPSE OF THE UMBILICAL CORD—ASPHYXIA NEONATORUM—SUDDEN DEATH DURING LABOR

PROLAPSE OF THE UMBILICAL CORD

It is customary to distinguish between *presentation* of and *prolapse* of the *funis* or umbilical cord. In the former the cord can be palpated through the intact membranes, while in the latter a loop of it protrudes through the cervix into the vagina, and exceptionally emerges from the vulva.

In general it may be said that any factor which interferes with the accurate adaptation of the presenting part to the superior strait predisposes to prolapse of the cord. Accordingly, the accident occurs most commonly in transverse and foot, and less often in frank breech presentations. On the other hand, it is rarely observed when the child presents by the head, unless accommodation is interfered with as a result of contracted pelvis, excessive development of the fœtus, hydramnios, or abnormal flaccidity of the lower uterine segment. For this reason it is much more common in multiparous than in primiparous women.

Prolapse of the cord is without appreciable effect upon the course of labor so far as the mother is concerned. On the other hand, it is one of the frequent causes of fœtal death, compression between the presenting part and the pelvic wall interfering with the circulation to such an extent that asphyxia and inevitable death often follow unless prompt delivery is effected. The danger is greater in vertex than in other presentations, for the reason that there is more likelihood that the cord will be compressed when the pelvic canal is filled out by the hard, rounded head than by the softer and more irregularly shaped part in other presentations.

Presentation of the funis is diagnosticated when on palpation a soft, pulsating, cordlike body can be felt through the membranes. In many instances, however, its recognition is only possible when the cord is in direct contact with the presenting part.

Prolapse of the cord, on the other hand, is readily recognizable, since on vaginal or rectal examination the fingers come directly in contact with a loop, while exceptionally it may be seen protruding from the vulva. In the latter event, the condition is self-evident, while in the former, mistakes are hardly possible, provided the fœtus is alive, as distinct pulsations are felt, although in their absence the condition is sometimes overlooked on superficial examination.

The possibility of prolapse of the cord should be particularly borne in mind in otherwise normal multiparous women in whom the membranes rupture while the head is still freely movable above the superior strait. In such cases the sudden cessation of the fœtal heart beat renders the diagnosis almost certain, even without vaginal examination.

Treatment.—The treatment to be pursued in any given case depends mainly upon the degree to which the cervix is dilated, and to a lesser extent upon the presentation of the child. In cases of presentation of the funis there is no immediate danger of compression so long as the membranes remain intact, and their premature rupture can sometimes be prevented by making counter pressure by means of a Champetier de Ribes bag in the vagina. In any event, every precaution should be taken to avoid their premature rupture, vaginal examinations being made with the utmost gentleness. Furthermore, the obstetrician should hold himself in readiness to effect delivery as soon as the cervix is sufficiently dilated.

In the absence of serious disproportion, if the cord prolapses under the observation of the obstetrician after the cervix has become fully dilated, the life of the child can usually be saved. No attempt at reposition should be made, but delivery should be effected at once. In cephalic and transverse presentations version is usually the operation of choice, but forceps are indicated when the head is already deep down in the pelvic canal. In frank breech presentations a foot, or preferably both feet, should be brought down and extraction promptly completed.

On the other hand, when the cervix is only partially dilated, the chances of a favorable outcome for the child are greatly diminished. If the cervical canal is obliterated and resistance is offered only by the external os, manual dilatation followed by version and extraction may give excellent results. On the other hand, if the condition of the cervix precludes manual dilatation, the chances for the child are poor unless cesarean section is promptly done. Consequently, the only hope lies in replacing the cord, and retaining it in place until the cervix dilates. For this purpose, if the presenting part is not deeply engaged, the patient should be placed in the knee-chest position, the entire hand introduced into the vagina, and an attempt made to push the cord up into the uterus and, if possible, to carry it over some projecting portion of the child's body. If the cord remains in place the patient should be made to lie upon the side toward which the child's back is directed in the hope of avoiding compression, and all danger is past if the head engages.

In the majority of cases, however, the prolapse recurs as soon as the hand is removed. In such circumstances an improvised repositor will sometimes serve in good stead, although the results attending its use are usually unsatisfactory. A piece of bobbin is firmly attached to the free end of a sterile bougie in such a manner as to leave a loop several inches long. This is then passed around the prolapsed cord and slipped over the tip of the bougie. By this means the cord can be carried up into the uterus, after which it may be freed from the repositor by bringing the loop in contact with a portion of the child and making traction so as to cause the loop to slip off from the tip of the bougie. Unfortunately, the condition usually recurs as soon as the repositor is removed; to insure against such an accident the bougie may be left in the uterus, but even this is only a forlorn hope.

If the pulsations in the cord are weak or have ceased altogether, no attempt at reposition should be made, inasmuch as the child has either already perished or will die before delivery can be effected. If, however, the cervix is fully dilated, such limitations do not hold good, as occasionally a child that is apparently hopelessly lost may be rescued by immediate delivery. On the other hand, if cesarean section is considered, no time should be lost in attempting such maneuvers, but immediate preparations for operation should be made. After their completion, the child's heart should be listened to, and the operation proceeded with only when its sounds are strong and regular; as it is absurd to subject the mother to an added risk and then to deliver a dead child. Furthermore, it should always be remembered that such interference is justifiable only in hospital practice, and then only when conscientiously indicated.

ASPHYXIA

Normally the fœtus while it remains in the uterus is in a condition of apnea, being satisfactorily supplied with oxygen by means of the placental circulation. As soon as delivery occurs, owing to the separation of the placenta or to the great diminution in its area of attachment, this source of oxygen is entirely cut off, or so greatly reduced that the necessity for active respiration arises. Generally speaking, imperfect oxygenation should be considered as the primary factor in the establishment of this function, although numerous accessory causes come into play during the act of delivery and just after birth.

Exceptionally, as the result of compression of the prolapsed cord, premature separation of the placenta, or much less commonly of tetanic contraction of the uterus, whether occurring spontaneously or following the administration of pituitrin, the supply of properly aërated blood through the umbilical vessels may be entirely or partially cut off while the child is still within the uterus. Occasionally a similar condition may be brought about by compression against the symphysis of a cord which is wrapped around the neck of the child, while now and again asphyxia and even death may result when the head is on the perineum, owing to excessive retraction of the active segment of the uterus, with a consequent diminution in the area of placental attachment.

As a result of the action of any of these factors the child may take its first breath while still in the uterus or in the lower portion of the birth canal. In the former case it may draw a certain quantity of amniotic fluid into its lungs, and when respiration begins while the head is in the vagina, a certain amount of mucus is liable to be aspirated. In either event the needed oxygen is not obtained, and the resulting air hunger leads to increased respiratory efforts, which are naturally of no avail. Gradually the accumulation of carbon dioxid and other excrementitious materials in the fœtal organism leads to such a pronounced decrease in the irritability of the medulla that eventually the attempts at respiration cease, the intervals between the pulsations of the heart become longer and longer, and the child dies from asphyxia.

Again pressure exerted upon the brain in difficult labors or in operative procedures may lead to vagus irritation and consequent slowing of the heart. As a result of the interference with the fœtal circulation the blood becomes poorer in oxygen and richer in excrementitious material; this goes on until at last the irritability of the medulla becomes so lowered that the usual stimuli fail to call forth the first respiratory movement and asphyxia results.

More often, the cerebral compression is the result of intracranial hemorrhage, which has followed rupture of cerebral or meningeal vessels following attempts on the part of the uterus to force the head through a contracted superior strait, or excessive pressure exerted by the blades of the forceps or during a breech extraction. When limited to the cerebral hemispheres a very considerable effusion of blood may occur without exerting an immediately deleterious effect upon the fœtus; but if the base of the brain is implicated a much smaller amount may give rise to serious disturbances.

Diagnosis.—The importance of watching for manifestations pointing to threatened intra-uterine asphyxia cannot be overestimated, inasmuch as their recognition frequently affords the indication for operative delivery, without which the life of the child is inevitably lost.

The most characteristic symptom is afforded by changes in the fœtal pulse rate. At first, as a result of momentary compression of the brain or interference with the placental circulation, it becomes slower with each uterine contraction, but regains its normal frequency in the intervals between the pains. As the condition becomes more serious, the remissions fail to occur and the pulse becomes slower and slower and eventually the heart ceases to beat. For practical purposes it is well to assume that a pulse rate of 100 or less for any great length of time is incompatible with life of the fœtus, and under such circumstances rapid delivery is indicated, provided it can be accomplished without too great risk for the mother. Exceptionally, the first sign of asphyxia is a marked increase in the frequency of the fœtal pulse, which may vary from 160 to 200. The acceleration, however, is only transient, and, as a rule, soon gives place to a definite slowing, which becomes still more pronounced as the fatal termination is approached. Such rules, however, have only an approximate value, and Baumm has pointed out their limitations, stating that the fœtal pulse may retain its normal rate notwithstanding the existence of severe intracranial hemorrhage, while in other cases, in which delivery has been effected on account of a very slow heart beat, the child may present no sign of asphyxia or of any other abnormality. Notwithstanding these generally recognized limitations, the fœtal heart rate constitutes the most available means of obtaining information concerning the condition of the child, and should be counted occasionally during the first stage of labor, and at intervals of ten or fifteen minutes during the second stage.

To neglect of this latter precaution can be attributed the death of many children, which otherwise could have been saved.

In vertex presentations another characteristic sign of impending asphyxia is the escape of meconium. This is due to relaxation of the sphincter ani muscle induced by faulty aëration of the blood. Accordingly, whenever the amniotic fluid presents a yellowish-green appearance and contains flakes of meconium, we may conclude that the child is in danger, and that the only hope for its safety lies in prompt delivery. In breech presentations, of course, this symptom is without significance, as it is a purely mechanical result of pressure applied to the abdomen of the fœtus.

Especially in difficult breech extractions, when delay is experienced in delivering the head, signs of asphyxia may appear in a child which was apparently in excellent condition before the operation. In such circumstances the finger in the child's mouth can readily appreciate the fact that vigorous inspiratory movements are being made. A similar phenomenon may occasionally be observed in vertex presentations, when the head is arrested on the pelvic floor, the movements of the mouth being felt or seen through the thinned-out perineum.

Very exceptionally the child may not only make inspiratory efforts, but actually give utterance to sounds *in utero—vagitus uterinus*. For the production of this phenomenon it is essential that air gain access to the fœtus, its entrance into the uterus sometimes resulting from the introduction of the hand or instruments. A very characteristic example of this phenomenon has been recorded by Bucura, who has collated the literature bearing upon the subject up to 1904.

Leaving out of consideration the simple apnea, which frequently follows the administration of an anesthetic, or of morphia within a few hours of the time of delivery, the asphyxiated newly born child may present one of two appearances—*asphyxia pallida* or *asphyxia livida*. In both respiration is in abeyance or occurs only in gasps, while the heart beats slowly and feebly. In the former the surface of the body is pale and cold, the extremities hang limp, and the child fails to respond to the usual external stimuli. In the latter, on the other hand, it presents a congested or livid appearance, which is usually attributed to overdistention of the right heart and the inferior vena cava.

Prognosis.—Asphyxia neonatorum is always serious, and is much graver in the pallid than in the livid type. The prognosis is relatively favorable when the condition is due to mechanical interference with the placental circulation, but is far less so when it results from injuries to the brain, such as intracranial hemorrhage, fractures, or depressions of the skull.

Treatment.—Normally, the child should make its first inspiratory movement a few seconds after it emerges from the vulva. If this does not occur, the feet being grasped by the fingers of one hand and the child suspended with its head downward, its body should be slapped gently with the other. If this maneuver does not prove immediately successful, and particularly if attempts at respiration are associated with a gurgling sound, a finger, covered with gauze, should be passed to the back of the pharynx for the purpose of removing any foreign material which may interfere with the free access of air to the laryngeal opening. Ordinarily, if the child is not deeply asphyxiated, these measures will bring about the desired results.

In many instances, however, more radical measures will be found necessary. In such cases the cord should be ligated and cut, and the child immersed in hot water, with only its head protruding, and rubbed vigorously. As soon as it takes on a pink color, it should be immersed for a moment in cold water, and usually upon coming in contact with it, an inspiratory movement is made and it begins to cry. If, however, we have to deal with the pallid type, the cold water should be omitted, as I am convinced that in the past the chances of many such children have been decreased rather than increased by too vigorous treatment. In such cases artificial respiration should be practiced by compressing the thorax five or six times a minute while the child is in the warm bath. If there is any reason to believe that the trachea and larger bronchi contain mucus or amniotic fluid, a small, soft-rubber catheter should be introduced into the larynx and the offending material removed by suction exerted by the obstetrician, or by the employment of a Ribemont-Dessaignes insufflator.

If these measures do not lead to the establishment of respiration, Laborde's method of resuscitation may be employed. For this, the child should be wrapped in a piece of blanket or flannel to prevent too rapid cooling, and laid upon a table or chair, the head being allowed to hang over the edge. The tip of the tongue is then grasped by a small pair of artery forceps and drawn forward as far as possible and then allowed to recede, the maneuver being repeated at regular intervals ten or twelve times to the minute. After the first few tractions an inspiratory movement usually follows, after which respiration goes on regularly, upon the principal that traction upon the tongue irritates the fibers of the superior laryngeal, glossopharyngeal, and lingual nerves, which in turn give rise to a reflex stimulation of the phrenic nerves with consequent contraction of the diaphragm and the intercostal muscles. Generally speaking, it is a very effective measure, and the prognosis becomes extremely gloomy if its employment is not attended by satisfactory results within a few minutes. Occasionally, its efficiency may be heightened by practicing it with the child immersed in a hot bath.

In 1928, Yandell Henderson stated that in our attempts at resuscitation we had overlooked the fact that carbon dioxide is the most efficient stimulus to the respiratory centers, and therefore he recommended that the child be made to breathe oxygen containing 5 to 6 per cent of carbonic acid gas. For this purpose, he devised a miniature respiration apparatus, which makes possible the administration of the gas mixture while the child is in a warm bath or a special warming device. As yet, I have had little experience with the method, but, in view of the eminence of its originator, I feel that it should be given an extended trial.

Formerly, before despairing of saving the child's life, Schultze's method was regularly employed, but it is falling more and more into desuetude. In this maneuver, as shown in Figures 719 and 720, the child is seized by both hands in such a manner that the index fingers of the operator lie under its axillæ, the thumbs over the thorax, while the palmar surfaces of the remaining fingers are applied to its back, the head at the same time being fixed by the balls of the thumbs. The obstetrician stands with his legs apart and at first allows the fœtus to hang down between them, he then slowly carries the child over his head in such a manner that the legs fall toward its face, so that the body becomes sharply flexed, after which he brings it back to its original position. The maneuver is repeated five or six times a minute. The *rationale* of the method is readily appreciated: the thorax is markedly compressed when the child is elevated, and expanded when it is lowered, the two positions favoring expiration and inspiration, respectively.

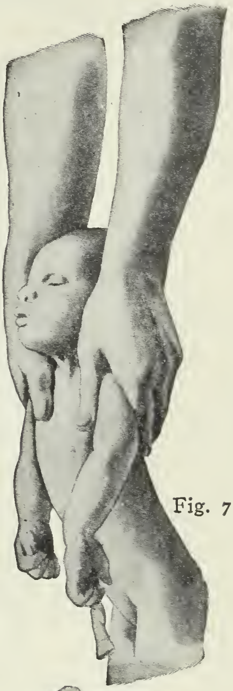

Fig. 719.

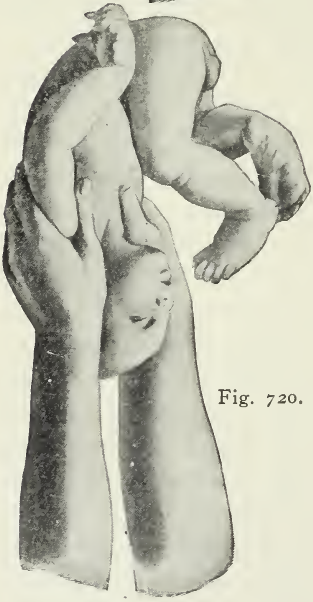

Fig. 720.

Figs. 719, 720. — Schultze's Method of Resuscitation.

Some idea of its efficiency may be gained by the fact that, when it is practiced upon a dead child, air can be distinctly heard to enter and leave the lungs with each movement. The procedure, however, is not without disadvantages; in the first place, it inevitably leads to great cooling of the child, and this deprives it of the warmth so urgently needed, and, in the second place, if too violently employed, it sometimes gives rise to fracture of the clavicles or ribs, and occasionally to rupture of the liver or other serious lesions of the internal organs. Moreover, in view of the no small degree of violence associated with its use, the maneuver is contra-indicated when the clavicle or humerus has been fractured during a difficult extraction, inasmuch as the free ends of the bones are liable to cause serious injury to the soft parts.

Byrd, in 1874, and Dew, in 1893, suggested a convenient substitute for Schultze's method. In this Byrd-Dew maneuver, the child is grasped with the left hand, allowing the neck to rest between the thumb and forefinger so that the head falls far backward; while the right hand grasps the legs in such a way that the right knee rests between the thumb and forefinger, and the left between the fore- and middle fingers, with the back of the thighs resting upon the palm of the hand. In order to bring about inspiration the child is gently bent backward, while the reverse movement compresses the thoracic contents and causes expiration. Dew claims that this method is less likely to cause injury to the child, and is much less fatiguing to the operator.

It might be mentioned that Israel, in 1927, enthusiastically recommended the use of the faradic current in the resuscitation of asphyxiated infants. I have had no experience with the method, and those interested are referred to his article, which contains a full bibliography.

Recently several patented devices have been put upon the market by means of which it is possible to pump into and withdraw from the lungs of the asphyxiated child regulated quantities of oxygen gas or atmospheric air. It is claimed that they offer the most efficient means of stimulating respiration. In my experience, however, they are not superior to the methods generally employed. At the same time they are unnecessarily expensive, and are being advertised in so objectionable a manner that self-respecting practitioners should hesitate to advocate their employment.

As asphyxia livida is associated with overloading of the right side of the heart, it is sometimes advisable to loosen the ligature at the free end of the cord so as to allow the escape of 15 cubic centimeters of blood. In obstinate cases some authorities recommend the injection of a few drops of whisky or ether, but I have not observed beneficial results following it.

When the asphyxia is the result of a depressed fracture of the skull, the depressed portion should be promptly elevated in the hope of removing the source of compression. Such an operation, however, should be attempted only when the heart still continues to beat strongly, though slowly.

Efforts at resuscitation should be persevered in as long as the heart continues to beat, one method after another being given a trial. The necessity for persistence is shown by the fact that successful results are occasionally obtained after trials lasting for thirty to sixty minutes, or even longer.

SUDDEN DEATH DURING OR SHORTLY AFTER LABOR

Ordinarily, death occurring during labor, or in the first few hours immediately following it, is the result of some one of the abnormalities to which allusion has already been made, particularly pulmonary embolism, acute edema of the lungs, apoplexy complicating eclampsia, or acute anemia the result of postpartum hemorrhage, placenta prævia, premature separation of the normally implanted placenta, or rupture of the birth canal. This subject was discussed in detail by E. P. Davis, in 1905, to whose article the student is referred.

In rare instances incomplete rupture of the uterus is unattended by symptoms at the time of its occurrence, the blood slowly accumulating between the folds of the broad ligament with a gradual development of symptoms of shock. A subperitoneal hematoma formed in this way is liable to rupture into the peritoneal cavity at any time within the first forty-eight hours after delivery and lead to sudden death.

Moreover, a woman in labor, or during the puerperium, may die suddenly from the effects of any condition which would give rise to a similar outcome under other circumstances. Thus, cases have been reported in which the fatal termination was due to rupture of an aortic or cardiac aneurism, hemorrhage from a gastric ulcer, or other accidents. Van der Velde has reported a case of a fatal retroperitoneal hemorrhage complicating an acute pancreatitis, while Node and Hines observed sudden death during labor following the rupture of an aneurism of the splenic artery.

In the chapter dealing with the Pathology of Pregnancy reference was made to the consequences of labor in women suffering from valvular lesions of the heart, particularly stenosis of the mitral orifice. Less frequently sudden death may be due to fatty degeneration or to changes in the myocardium. Such accidents are to be particularly dreaded in elderly and corpulent women.

Shock.—Formerly it was customary to attribute a certain number of deaths following labor to shock, which was supposed to occur occasionally after prolonged and very painful labors, the incidental loss of rest, imperfect nutrition, and mental excitement being looked upon as predisposing causes. In the present state of our knowledge, however, this explanation is hardly permissible, since in the majority of such cases a carefully performed autopsy will reveal the existence of some condition sufficiently serious to account for the unfavorable outcome. Schickele has reported convincing cases in which profound, but unsuspected, toxemia or larval infection was the underlying cause.

Syncope.—Faintness is not an uncommon result of exhaustion following prolonged labor, and in neuropathic individuals may occur even after an easy and rapid delivery. In rare instances it may be due to cerebral anemia resulting from lack of blood in the nervous centers following the sudden diminution in the intra-abdominal pressure incident to the rapid decrease in the size of the uterus.

The faintness usually passes off rapidly and does not lead to untoward results. On the other hand, it occasionally gives cause for serious alarm, the pulse becoming weaker and more rapid and the patient remaining in a condition of profound prostration. I have never seen a death from this cause, but can recall one patient who caused me the greatest anxiety, and who seemed to be in imminent danger for hours.

Haig Ferguson reports 3 cases of serious exhaustion following labor in which he was inclined to attribute the condition to reflex irritation resulting from stimulation of the nerve supply of the uterus following the employment of Credé's method of expressing the placenta, the organ being grasped laterally instead of anteroposteriorly.

Profound Mental Depression.—In rare instances the only apparent explanation for death, or for a profound collapse which eventuates in recovery, is to be found in the mental condition of the patient, since the most careful examination both at the bedside and at autopsy, may fail to reveal the slightest abnormality.

I recall a case in my own practice which apparently belongs in this category.

The patient, who was unhappily married, had already passed through two difficult labors. When I saw her, in the latter part of the first stage of her third labor, she was about the room. Just before going to bed at the beginning of the second stage she asked the nurse and me to witness her will, as she said she felt sure she would not survive. The labor was rapid and uneventful, the placenta coming away spontaneously. An hour later, on approaching the bed to take leave of the patient, I was struck with her haggard appearance. Fearing the possibility of concealed hemorrhage I at once applied my hand over the uterus and found it tightly contracted, while the pulse was of excellent quality. Without any apparent reason, and in spite of energetic stimulation, the patient grew slowly worse, the pulse becoming rapid and weak, the eyes sinking back in their sockets, and the face assuming a drawn and hippocratic expression.

Thorough examination failed to reveal any apparent cause for the condition. The hand introduced into the uterus could find no trace of rupture. Eight hours after delivery I requested a colleague to see her in consultation, but he also was unable to offer any explanation. It then occurred to me that the condition might possibly be the result of her morbid forebodings, and acting upon that supposition I administered a large dose of morphin hypodermically, which was promptly followed by a sound sleep, a marked improvement in the character of the pulse, and a rapid change for the better in the general appearance. Upon awakening a few hours later the patient felt comfortable and later made an uninterrupted recovery.

Pulmonary Embolism.—This accident, usually noted only later in the puerperium, but occasionally occurring shortly after labor, is due to the detachment of a small particle of thrombus situated in a uterine or pelvic vein or elsewhere, which is carried to the right side of the heart and leads to more or less complete occlusion of the pulmonary artery. It is usually associated with infective or thrombotic processes elsewhere in the body, though it may occur in women who were apparently perfectly well. Davis considers it the most frequent cause of sudden death in the absence of definite disease. Under such circumstances the patient complains of intense and sudden precordial pain, becomes livid in appearance, and presents symptoms of profound dyspnea and eventually of air hunger. These embolisms, however, are not always fatal, a certain proportion of the patients recovering.

The treatment is purely palliative. The woman should be placed in the recumbent position, kept in absolute rest, and given the necessary sedatives, particularly morphia and bromide of potassium. When indicated, inhalations of oxygen may prove beneficial.

Entrance of Air into the Uterine Sinuses.—Occasional cases of death following intra-uterine manipulations in women suffering from placenta prævia or rupture of the uterus have been attributed by certain authorities to the entrance of air into the uterine sinuses, whence it is carried to the heart. The exact cause of death is not understood, some holding that the air bubbles enter the coronary arteries, and others that the right heart, being unable to rid itself of them, becomes paralyzed as a result of its fruitless efforts. The symptoms are analogous to those following pulmonary embolism. Cases of this character have been reported by Olshausen, Lesse, Perkins, Roger, and others, but I have never encountered one.

That such a condition may occur is clear from the fact that cases have been reported in which sudden death followed the pumping of air into the pregnant uterus for the purpose of producing abortion. On the other hand, it is probable that its frequency has been overestimated, as most of the cases which have come to autopsy, and which were supposed to demonstrate such a possibility, are open to another and far more reasonable explanation. Thus, Dobbin was able to demonstrate the presence of Bacillus aërogenes capsulatus in the tissues from one of Perkins' cases, in which autopsy had apparently demonstrated that air embolism had been the cause of death. Wendeler had a similar experience, and it would therefore seem permissible to regard with skepticism all cases of supposed air embolism unless death had occurred almost instantaneously, or in which careful bacteriological investigation had failed to demonstrate the presence of gas bacilli.

Acute Dilatation of the Stomach.—Very exceptionally following operative as well as spontaneous labor, the patient may pass into a condition of profound shock, associated with symptoms of acute dilatation of the stomach—great distention of that organ and the expulsion of immense quantities of dark fluid vomitus—and death may follow, or recovery ensue, just as in the similar condition, which is so well known to surgeons.

I have encountered the complication upon one occasion. In this instance a healthy woman, one hour after the completion of an easy spontaneous labor, passed into a condition of profound shock and hovered between life and death for twenty-four hours. The first manifestation was a change in the character and rate of the pulse, but the true condition was not suspected until the onset of the characteristic vomiting shortly afterwards.

Audebert, in 1912, was able to collect 12 cases from the literature. As labor was spontaneous in three of them, he was inclined to attribute the condition to paralysis of the stomach due to the action of the chloroform. As my patient received only a minimal amount of the drug, I sought the etiological factor in an arterioduodenal occlusion following the acute diminution in the bulk of the abdominal contents, incident to the sudden decrease in the size of the uterus. Whatever the cause may be, the condition is most serious, and now that attention has been called to its possibility it should be recognized as one of the causes for sudden death following delivery. The best results are obtained by placing the patient in an inclined position, with the head considerably lower than the feet, emptying the stomach by a suitable tube, and stimulating according to the exigencies of the case.

Postmortem Delivery.—In the literature, which has been carefully searched by Aveling and Reimann, a number of cases are recorded in which spontaneous birth of the child took place some hours or days after the death of the mother.

Moreover, delivery sometimes occurs after burial, and, when the body has been exhumed for some reason, two individuals instead of one have been found in the coffin. These are instances of the so-called "coffin birth." The phenomenon is usually observed in multiparous women in whom the birth canal is greatly relaxed, and is attributable to a marked increase in the intra-abdominal pressure produced by putrefactive changes, though Hellendahl and others believe when delivery occurs within twenty-four hours after death that it may be the result of automatic contractions of the uterus, which continue for hours after the patient has ceased to live.

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SECTION VIII

PATHOLOGY OF THE PUERPERIUM

CHAPTER XLIII

PUERPERAL INFECTION

Under the general heading of "Puerperal Infection" are now included all the various morbid conditions which result from the entrance of infective micro-organisms into the female generative tract during labor or the puerperium. The older term, "puerperal fever," is at once too vague and misleading, and for many reasons should be discarded. In the first place it suggests the old idea of the essentiality of the affection so strongly urged by the late Fordyce Barker, and takes no account of the various etiological factors which may be concerned. Moreover, it emphasizes the febrile phenomena of the affection, instead of laying stress upon its infectious nature and the consequent responsibility of the obstetrician and his assistants. Again, "puerperal septicemia" and "puerperal sepsis," which are often used as synonymous terms, are hardly more satisfactory, inasmuch as in many instances the infection results in localized inflammatory processes, to which such terms cannot be applied without violating the established rules of diction.

It is probable that puerperal infection has occurred almost as long as children have been born, and passages in the works of Hippocrates, Galen, Avicenna, and many of the old writers clearly have reference to it. As early as 1676, Willis wrote on the subject of *febris puerperarum,* although the English term "puerperal fever" was probably first employed by Strother in 1718.

The ancients regarded the affection as the result of retention of the lochia, and for centuries this explanation was universally accepted. In the early part of the seventeenth century Plater taught that it was essentially a metritis, and was followed in the next century by Puzos with his milk metastasis theory. From the time of Plater, until Semmelweiss had proved its identity with wound infection, Pasteur had cultivated the streptococcus, and Lister had demonstrated the value of antiseptic methods, all sorts of theories were suggested concerning its origin and nature, which are comprehensively dealt with in the monographs of Eisenmann, Silberschmidt, and Burtenshaw.

Bacteriology.—Although Charles White (1793) and Alexander Gordon (1795) clearly recognized the contagious nature of puerperal infection, and many other British observers had vague ideas upon the subject, it was not until the middle of the nineteenth century that such views were strongly urged. In 1843, Oliver Wendell Holmes read a paper before the Boston Society for Medical Improvement, entitled "The Contagiousness of Puerperal Fever," in which he clearly showed that at least the epidemic forms of the affection could always be traced to the lack of proper precautions on the part of the physician or nurse. Four years later Semmelweiss, then an assistant in the Vienna Lying-in Hospital, began a careful inquiry into the causes of the frightful mortality attending labor in that institution, as compared with the comparatively small number of women succumbing to puerperal infection when delivered in their own homes. As a result of his investigations he concluded that the morbid process was essentially a wound infection, and was due to the introduction of septic material by the examining finger. Acting upon this idea he issued stringent orders that the physicians, students, and midwives should disinfect their hands with chlorine water—the forerunner of Dakin's solution—before examining parturient women. In spite of immediate surprising results—the mortality falling from over 10 to about 1 per cent—his work, as well as that of Holmes, was scoffed at by many of the most prominent men of the time, and his discovery remained unappreciated until the influence of Lister's teachings and the development of bacteriology had brought about a revolution in the treatment of wounds.

It should be mentioned that Semmelweiss was not the first to utilize a solution of chlorinated lime in the treatment of puerperal infection, as he was preceded by Thomas Alcock as early as 1827.

It is now universally acknowledged that puerperal infection is wound infection, and is due to the invasion of the generative tract by various pyogenic bacteria. The principal micro-organisms concerned are the following:

(*a*) *Streptococcus.*—As early as 1865 this organism was discovered by Mayrhofer in the tissues of women who had died during the puerperium, and confirmatory observations were made by Coze and Feltz, Recklinghausen, Waldeyer, Klebs, Orth, and Heiberg. Pasteur, in 1880, however, was the first to cultivate streptococci from the cases of puerperal infection, and originally he called them "chapélets en grains." He was assisted by Doléris, who showed that they were the usual infectious agents, but that other bacteria were sometimes concerned. These researches were soon confirmed by Lomer, Bumm, Döderlein, Winter, Widal, and by all subsequent observers, so that the streptococcus is now believed to be the usual cause of the epidemic and fatal forms of puerperal infection.

In 1903, Schottmüller showed when streptococci, obtained from seriously ill patients, were grown upon blood agar that each colony became surrounded by an area of hemolysis, which was lacking in the other varieties of the organism. His findings were confirmed by others, so that it was believed for a time that three types could be differentiated—Streptococcus pyogenes, Streptococcus mitior or gracilis, and Streptococcus mucosus. It was held that the first, which is always hemolytic, was concerned in the production of virulent infections, while the other varieties, which are lacking in hemolytic properties, were either saprophytic or only slightly pathogenic in character.

It is now generally recognized that such conclusions were too sweeping, and that while hemolytic streptococci are frequently associated with the most serious types of infection, they are not always so, and occasionally it is possible to isolate them from women who are scarcely sick. Furthermore, the nonhemolytic variety is occasionally very pathogenic, while the anaërobic type is frequently encountered in the serious thrombophlebitic form of infection. Since the hemolytic property may either be lost or accentuated by various cultural methods, it would appear inadvisable to consider its existence as characteristic of a distinct species of streptococcus; although one might hesitate to go so far as Sigwart, and others, in holding that all types of streptococci are interchangeable.

Although Krönig, myself, and others had previously isolated an anaërobic streptococcus, it was not until 1910 that Schotmüller demonstrated its practical importance. By the use of suitable anaërobic culture media, all subsequent investigators have been able to isolate it frequently. Schottmüller believed that it is more commonly concerned in the production of puerperal infection than the aërobic variety; while in our series it constitutes between one-third and one-half of all streptococcic strains. Schwarz and Dieckmann concur in this opinion, and believe with Sommer that it is especially concerned in thrombophlebitis. As the organism frequently produces large amounts of sulphureted hydrogen, Schottmüller designated it as Streptococcus putridus. That term, however, is less inclusive than anaërobic streptococcus as a considerable fraction of the latter are not gas producers. In general, it is fair to assume that in the past many infections due to it were loosely grouped together as being saprophytic in origin.

(*b*) *Staphylococcus.*—Further investigation gradually demonstrated the fact that the streptococcus is not the only organism which may be concerned, but that most of the pus producers, which give rise to wound infection in other parts of the body, may likewise at times be the exciting factors.

Brieger, in 1888, reported that he had demonstrated Staphylococcus aureus in five fatal cases. Doléris, in 1894, identified as staphylococci bacteria which he had cultivated years previously, and since then it has been generally admitted that both the Staphylococcus aureus and albus may be concerned. The latter usually give rise to mild infections as stated by Fehling and Haegler, while the former which may occur in a hemolytic or anaërobic form, may cause severe infection. Indeed, Sommer goes so far as to claim that the hemolytic staphylococcus aureus is responsible for more deaths than the Streptococcus hemolyticus. This is contrary to my experience, as I have only seen a single death from it in the many years I have been interested in the bacteriological aspects of puerperal infection. The citreus is rarely observed.

(*c*) *Gonococcus.*—Although clinicians had long suspected that gonorrhea frequently plays a part in the production of puerperal infection, Krönig was the first to adduce bacteriological proof. In 1893 he reported 9 cases of mild infection, in which he was able to obtain pure cultures of gonococci from the uterine lochia. In a later communication he stated that he had been able to cultivate the same organism from the discharges of 50 out of 179 febrile puerperal patients, most of whom recovered spontaneously; while we have found it in approximately 9 per cent of our febrile patients whenever suitable culture media have been used.

Krönig's experience has been confirmed by all subsequent investigators, and Taussig, and Stone and McDonald state respectively that one-sixth to one-tenth of all rises of temperature in the puerperium are the result of gonorrheal infection. As far as I am aware, Foulerton and Bonney are the only recent writers who have not had a similar experience. Furthermore, I have repeatedly demonstrated the gonococcus in the tissues of cases of decidual endometritis, and others have made similar observations. As a rule, gonorrheal infection in the puerperium pursues a favorable course, but occasionally fatal septicemia may result, as in two of my cases reported by Harris and Dabney, and J. T. Smith.

(*d*) *Bacillus Coli Communis.*—In my first article upon puerperal infection (1893), it was stated that von Franqué had cultivated the colon bacillus from a case of puerperal infection, and the belief was expressed that it would be demonstrated more frequently in the future. Time has amply verified that prediction, and there are now on record a long series of such cases. *A priori,* this is what would be expected when one takes into consideration the proximity of the genital tract to the rectum, and the enormous numbers of colon bacilli which are evacuated. As Vignal has shown that 1 decigram of feces contains about 20,000,000 colon bacilli, it is evident that the examining finger can hardly avoid contamination with them if it comes in contact with an imperfectly disinfected perineum.

Gebhard demonstrated their presence in 7 cases of tympania uteri, either alone or in combination with other organisms, and we have repeatedly found them in cases of intrapartum infection, and occasionally in the circulating blood.

Ordinarily pure colon infections are relatively benign in character, but occasionally, as shown by Lenhartz and others, fatal septicemia may ensue. In many seriously sick women the colon bacillus is associated with the streptococcus, and it appears that such a combination tends to augment the virulence of both species of bacteria.

(*e*) *Bacillus Diphtheriæ.*—Formerly it was believed that the diphtheritic deposits upon the vagina and the interior of the puerperal uterus were due to the streptococcus alone, and were in no way connected with true diphtheria. That this is not always the case, however, has been shown by the observations of Nisot, Bumm, Lop, myself, and others who have cultivated the Klebs-Loeffler bacillus from the diptheritic membrane in the vagina, the affection yielding promptly to the use of the antidiphtheritic serum. Gide, in 1911, was able to collect 42 such cases. Wauschkuhn states that such infections are not uncommon, and that in a series of 200 apparently healthy women he found diphtheria bacilli nearly as frequently in the vaginal secretion as in the tonsils.

(*f*) *Bacillus Aërogenes Capsulatus* (Gas Bacillus).—The gas bacillus of Welch is occasionally concerned in puerperal infection, especially when it follows criminal abortion. In 1896 I observed an instance of the kind, which was reported by Dobbin. Briefly stated, the case was as follows: An outdoor patient had been in labor for several days under the care of a midwife. When she came into our hands she was profoundly infected and the head of a macerated child was found firmly engaged in the contracted superior strait, the uterus being in a state of tetanic contraction. A fetid, dark-colored discharge, which contained many gas bubbles, was escaping from the vagina with a crackling sound. Delivery was effected by craniotomy, and death occurred the next day. Within a few hours the patient's body had nearly doubled in size, as the result of the development of gas in the subcutaneous tissues. Similar changes were observed in the fœtus and in the placenta, in both of which, as well as in the uterine lochia, the presence of the gas bacillus was demonstrated. Unfortunately, no autopsy was allowed upon the mother, and we were therefore unable to say to what extent the organisms had penetrated her tissues.

Following this, many well-authenticated instances of infection with this organism have been reported, and the entire literature was exhaustively reviewed by Welch, in 1900, and later by Heynemann, Fraenkel and Toombs. Little, in 1905, reported 10 cases in which the gas bacillus had been isolated in our service, and pointed out that in all probability it was identical with the "vibrion septique" of Pasteur, as well as with Bacillus perfringens described by various writers. In several of our cases the bacillus was in pure culture, but in most of them it was associated with various bacteria—particularly with streptococcus.

As a rule, the gas bacillus exists merely as a saprophyte upon dead material, and does not invade the deeper tissues until shortly before or just after death, but in several of my patients it gave rise to a true septicemia. Accordingly, the prognosis is usually favorable when the organism occurs in pure culture, but becomes very serious when it is associated with the streptococcus, as it would seem that such an association tends to augment the virulence of both organisms. According to Welch, its presence in the puerperal uterus may give rise to emphysema of the fœtus, endometritis, physometra, emphysema of the uterine wall, or gas sepsis. Moreover, it is important to remember, as was first pointed out by Welch and Dobbin, that the gas bubbles found in the blood vessels of women supposed to have perished from "air embolism" are frequently the product of the bacillus in question.

(*g*) *Bacillus Typhosus.*—In 1898 Dobbin and I isolated Bacillus typhosus, Streptococcus, Staphylococcus aureus, and an unidentified anaërobic gas-producing bacillus from the uterine lochia of a Bohemian woman who was admitted to the Johns Hopkins Hospital on the fifth day of the puerperium with high fever. Her blood gave the characteristic Widal reaction, but all the usual symptoms of typhoid fever were absent. The temperature fell to normal on the thirteenth day, and did not rise again. We were inclined to believe that the bacilli were introduced into her uterus by the midwife, along with other organisms, since she was delivered upon the same bed upon which her husband had died of typhoid fever a few days previously. Since then we have cultivated the typhoid bacillus from the uterine lochia on several occasions. On the other hand, in the case reported by Blumer, in which the autopsy revealed an unsuspected typhoid fever, the presence of typhoid bacilli in the lochia should be regarded as evidence of typhoid septicemia, rather than of puerperal infection.

(*h*) *Pneumococcus.*—In rare instances this organism may be found in the vaginal secretion of apparently healthy pregnant women, and may give rise to puerperal infection, which is particularly liable to eventuate in peritonitis. Foulerton and Bonney, and Natwig have reported cases in which it was found, and Hornung has collected the literature upon the subject up to 1920.

Occasionally the presence of pneumococci in the uterine lochia is merely a manifestation of a general septicemia originating from a focus outside of the generative tract, as reported by Czemetschka, and Burchhardt, as well as by Johnston and Morgan from our clinic and others. Bondy has pointed out how difficult it may be in a given case to determine whether such a finding should be regarded as evidence of external infection or of transportation by the blood stream.

Still more occasionally, the pneumobacillus of Friedländer may be isolated, as was shown by the observations of Howard, Fromme, Chirié and others.

(*i*) *Bacillary Infections.*—Perkins, Charrin, and others have recorded cases in which the Bacillus pyocyaneus was the infectious agent. Moreover, isolated observations of Fränkel, Doléris, Widal, Mixius, Goldscheider, Bumm, and others tend to show that certain cases of fatal infection may be due to unidentified bacilli with whose properties we are as yet unacquainted. Moreover, bacteriological examination of the uterine lochia from normal women, as well as from those presenting febrile puerperia, frequently shows the presence of organisms resembling the Bacillus diphtheriæ—the so-called *diphtheroids*. These may occur in pure culture or in association with other bacteria. Some grow only aërobically and others anaërobically, and present other cultural variations. In pure culture they are rarely pathogenic, but it is not yet known what their effect is when associated with other bacteria. In other infections, bacilli are visible in smear preparations, but cannot be cultivated upon the media currently employed.

(*j*) *Actinomyces Pseudo-Necrophorus.*—In 1927, Harris and Brown in our clinic isolated from several infected patients a peculiar organism growing in long jointed chains, which they identified as Actinomyces pseudonecrophorus. This organism frequently occurs in veterinary practice, and they assume that it may play a pathogenic rôle in women, particularly when much necrotic tissue is present.

(*k*) *Sapremia.*—Besides the cases in which the infection is due to the growth and extension of micro-organisms within the body, there is a large group in which the symptoms are due to the absorption of toxins produced by bacteria which do not invade the tissues nor make their way into the blood current. To this form of infection Matthews Duncan applied the term *"sapremia."* It is usually thought to be due to putrefactive organisms with whose properties we are as yet almost totally unfamiliar.

Formerly this term was freely used, but now it is regarded as a confession of ignorance. Following the isolation by Bumm of Streptococci from 8 out of 11 patients who were thought to present the clinical picture of sapremia, we have become more and more skeptical as to its existence, and by the employment of special culture media, and particularly those favoring anaërobic growth, it has been possible to isolate and identify a constantly increasing number of cocci as well as bacilli, many of which are gas producers, which were formerly grouped together as putrefactive bacteria. Moreover, in 1921, Bingold, a pupil of Schottmüller, greatly increased our knowledge concerning the part played by anaërobic bacteria, and isolated several varieties which had not been described up to that time. Thus, Sackenreiter, in 1912, was able to isolate the causative factor in 88 per cent of his cases of putrid endometritis, and found the colon bacillus, an anaërobic staphylococcus, the Streptococcus putridus, an influenzalike bacillus, various unidentified anaërobic bacilli, the gas bacillus and the Bacillus pyocyaneus. Furthermore, it is probable that a considerable number of cases from which we now isolate anaërobic streptococci, either in pure culture or in association with other bacteria, were formerly regarded as sapremic in character.

For years it has been the custom in our clinic to study the uterine lochia bacteriologically whenever the temperature reaches 101° F. or more on two consecutive days during the first week of the puerperium, and the table below gives an idea of our findings in the last 208 cases ending October 31, 1929. In this series no effort was made to cultivate the gonococcus, which will explain its absence from the list.

	Cases
Aërobic beta-hemolytic streptococcus, alone	13
Aërobic beta-hemolytic streptococcus, mixed	12
Aërobic nonhemolytic streptococcus, alone	7
Aërobic nonhemolytic streptococcus, mixed	66
Anaërobic streptococcus, alone	14
Anaërobic streptococcus, mixed	42
Aërobic streptococcus viridans, alone	1
Aërobic streptococcus viridans, mixed	1
Staphylococcus albus, mixed	9
Bacillus coli communis, mixed	8
Bacillus typhosus, mixed	1
Bacillus welchii, mixed	1
Bacillus pseudonecrophorus, mixed	1
Anaërobic gram + coccus in tetrads	1
Diphtheroids, alone	19
No growth	12
TOTAL	208

Harris, in 1929, published the results of a study of 103 consecutive cases occurring prior to August 29, 1927, from which streptococci were isolated and studied with all the refinements of present-day bacteriological technic, with the following results:

	Cases	
Anaërobic streptococci		54
Alpha-viridans	5	
Viridans, nonhemolytic	1	
Gamma	48	
Aërobic streptococci		49
Alpha	1	
Alpha-viridans	12	
Beta	17	
Gamma	19	
TOTAL		103

From a practical point of view it is interesting to note that only two deaths occurred in Harris' series. From both of these beta-hemolytic streptococci were isolated, but the actual cause of death was eclampsia in one and lobar pneumonia in the other case.

Besides the organisms already mentioned, it is not unlikely that further research will show still others which may play a part in the production of isolated cases of puerperal infection; but, to summarize, it may be said that those most commonly concerned are the well-known pyogenic organisms (streptococcus, staphylococcus, colon bacillus, gonococcus, and pneumococcus) and the various putrefactive varieties.

Pathological Anatomy.—The lesions may vary widely even in cases clinically similar, and such variations afford a probable explanation for the failure of the older authors to appreciate the true nature of the affection. Thus, there may be an almost infinite series of gradations from a slight membrane covering a small perineal tear to an inflammatory process involving the entire generative tract, or extending beyond it to the parametrium or peritoneum, and sometimes resulting in a systemic infection. In other cases the infectious elements pass through the portal of entry with such rapidity that they do not excite local lesions, but produce a septicemia which is rapidly fatal—the *sepsis foudroyante* of the French authors. In the majority of cases the morbid process is limited to the endometrium, resulting in a puerperal endometritis. In other cases the lesions may be situated in any part of the generative tract, more than one region being frequently implicated. Thus, at different times we have to deal with puerperal vaginitis, endometritis, metritis, parametritis, metrolymphangitis, metrophlebitis, salpingitis, oöphoritis, peritonitis, pyemia, or phlegmasia alba dolens, respectively.

Lesions of the Vulva and Vagina.—In former times the *puerperal ulcer* was of very common occurrence, but with the introduction of aseptic methods its frequency has become greatly diminished.

These ulcers appear on the surface of tears about the vulva and perineum, soon take on a dirty, greenish-yellow appearance, and are bathed in a foul-smelling secretion. As the result of necrosis they are sometimes covered by a grayish-white membrane, and on that account were formerly designated as "diphtheritic ulcers," but, except for their external appearance, they have nothing in common with diphtheria. As a rule they give rise to very little systemic disturbance, and would frequently pass unnoticed were it not for ocular inspection.

Puerperal Vaginitis.—Of this there are two forms, the one being characterized by general inflammation, the mucosa becoming thickened, soft, reddened, and bathed with an abundant purulent secretion. In the other type, especially when torn surfaces are present, the vaginal walls may be the seat of a pseudo-diphtheritic membrane, which may vary in extent from a small patch covering a tear to a complete cast of the entire vaginal canal.

Following the recognition of the predominant rôle played by the steptococcus, it was believed for a time that none of the so-called cases of *diphtheria* of the vagina were due to invasion by the Klebs-Loeffler bacillus; but subsequent investigation has shown that the latter organism is occasionally the etiological factor.

Endometritis.—The most common lesion in puerperal infection is an inflammation of the endometrium. When one recalls the condition of the uterine cavity immediately after delivery, with its bleeding, raw surfaces and the large, gaping, thrombosed placental sinuses, it becomes apparent that pathogenic bacteria introduced during labor can easily find entry. Again, when one considers the mechanism by which the decidua is normally removed during the puerperium, one can readily see that an ideal culture medium is prepared by Nature for their reception and propagation.

In puerperal infection the process may be limited to the placental site, or may extend over the entire interior of the uterus. When the former alone is implicated, the organisms are usually found growing into the thrombi. They produce comparatively little local reaction, but may give rise to the thrombophlebitic type of infection, which will be described below. On the other hand, when the entire internal surface of the uterus is affected, puerperal endometritis results. In this event, the lesions vary considerably according to the micro-organisms concerned, and still more according to their virulence. When the infection is due to a virulent streptococcus or staphylococcus, the local lesion may be comparatively slight, the discharge scanty, and comparatively free from odor (Fig. 721). In such cases the process tends to spread rapidly through the lymphatics or veins past the uterus, and gives rise to a peritonitis or a general systemic infection. On the other hand, when the infection is due to streptococci of lesser virulence, and particularly when they are associated with colon bacilli, the entire interior of the uterus is converted into a sloughing area made up of necrotic material and decidual débris and bathed with a foul-smelling, bloody, purulent discharge (Fig. 722). In some instances ulcerated areas appear, which are coated with fibrin and present the clinical picture of diphtheria. This was formerly designated as diphtheritic endometritis, but, just as in the case of the vagina, the condition, as a rule, simply represents a fibrinous exudation, the result of intense necrosis.

When the infection is due to putrefactive bacteria, to the colon bacillus, or to the ordinary pus organisms of slight virulence, the process usually remains limited to the uterus, and results in so-called putrid endometritis. In this event large amounts of necrotic material may be produced, in which the bacteria lead a saprophytic existence, and give rise to a profuse, foul-smelling, bloody discharge, which frequently contains gas bubbles. The amount of necrotic material produced is often enormous, and may recur with great rapidity after curetting. Figure 722 represents a uterus infected with streptococcus and colon bacillus. The woman succumbed ten days after the birth of the child in another hospital, the uterus having been scraped clean by means of a curet three or four days

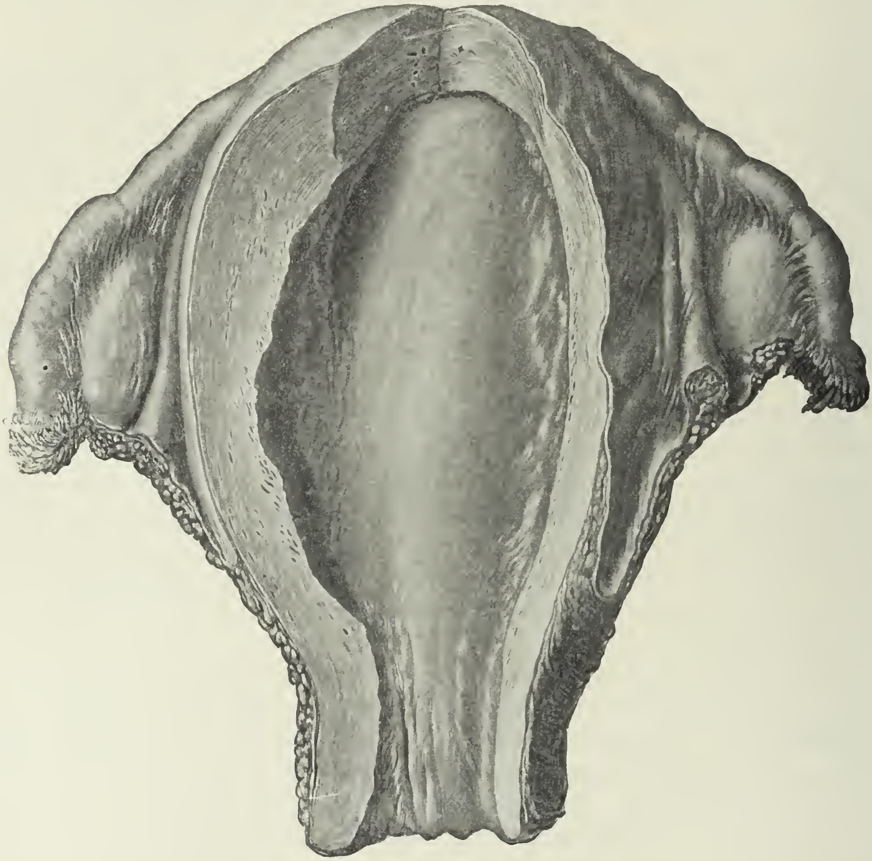


Fig. 721.—Uterus from Woman Dying Ten Days after Labor from Streptococcus Infection. × ⅔.

previously. A glance at the drawing, however, shows that the entire cavity is filled with necrotic material, which had been reproduced in the interval following the curettage.

Upon studying the microscopical features of puerperal endometritis, these differences are still further accentuated. Our original knowledge on this point we owe to Bumm and Döderlein, both of whom have shown that there are marked histological differences between the putrid and septic forms, and my own experience has confirmed their conclusions. In sections through the wall of a uterus the seat of *putrid endometritis,* a thick layer of necrotic material is found lining the uterine cavity, embedded in which are large numbers of the offending micro-organisms. Beneath it is a thick layer of leukocytic infiltration—the zone of reaction—and, under this again, more or less normal tissue. The micro-organisms are limited almost entirely to the superficial necrotic layer; and although a few may be present in the reaction zone, none can be made out in the tissues beneath it, thus showing Nature's mode of preventing general invasion of the body (Figs. 723 and 724).

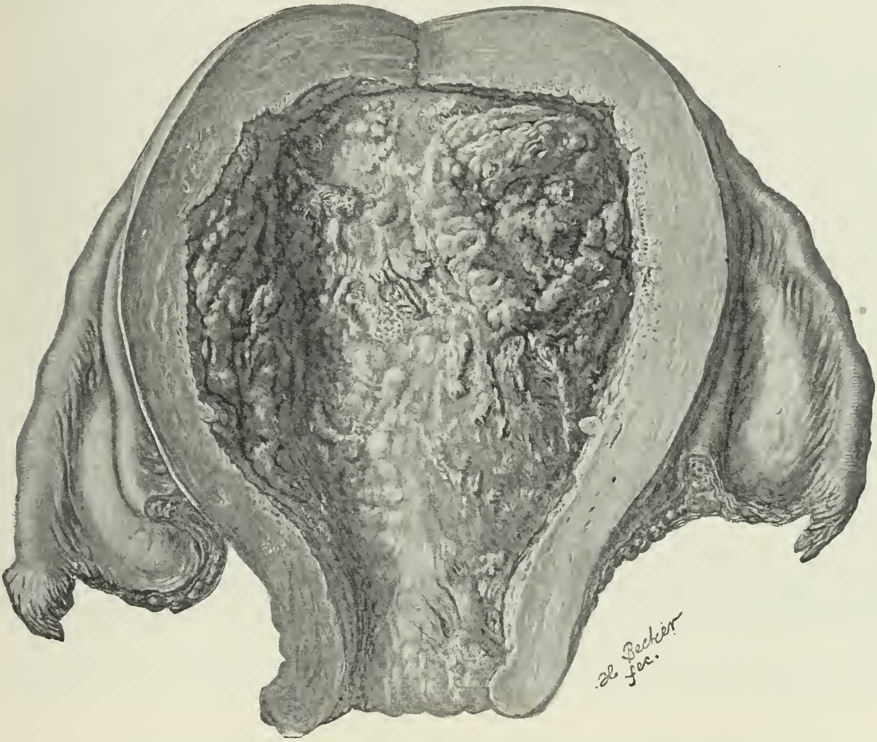


Fig. 722.—Uterus from Woman Dying Ten Days after Labor from a Mixed Infection with Streptococcus and Bacillus Coli. × ⅔.

On the other hand, in *septic endometritis,* and especially when the organisms are very virulent, a totally different appearance is noted. Although a layer of necrotic material containing organisms adjoins the uterine cavity, it is usually thinner than in the preceding case. The zone of leukocytic infiltration is either lacking or very imperfectly developed, and the micro-organisms can be observed making their way down through the decidua and along the lymphatics of the muscular wall of the uterus out towards its peritoneal surface (Figs. 725 and 726).

It would appear, therefore, that Nature endeavors to confine the micro-organisms to the inner surface of the uterus by interposing between the necrotic layer and the deeper portions a barrier of leukocytic infiltration, which acts as an efficient filter when the bacteria are attenuated, but fails to restrain them when they possess a marked degree of virulence.

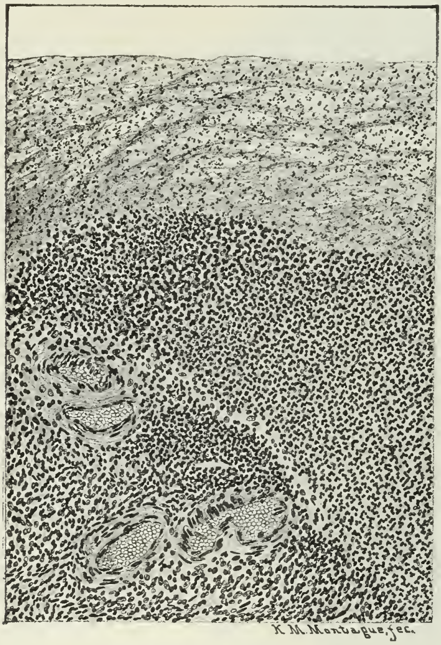


Fig. 723. — Puerperal Endometritis Due to Colon Infection, Showing Marked Development of Leukocytic Wall.

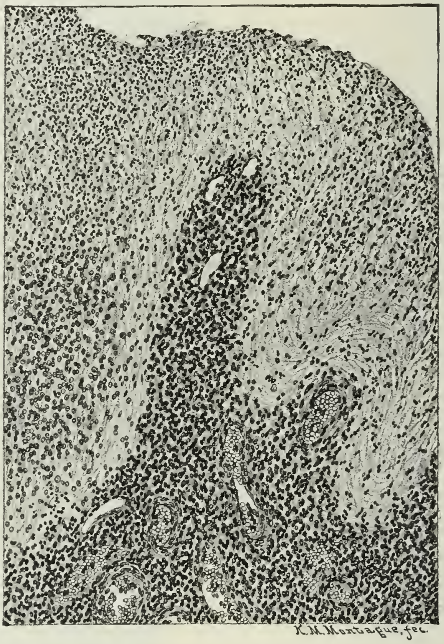


Fig. 724. — Puerperal Endometritis Due to Virulent Streptococcus Infection, Showing Slight Development of Leukocytic Wall.

As has already been pointed out, in a considerable proportion of cases the inflammatory process extends into the uterine musculature, and there gives rise to divers lesions of *metritis,* which may vary from small areas of leukocytic infiltration to definite abscess formation. As such multiple abscesses are due to implication of the lymphatics, and, inasmuch as these channels are most numerous beneath the peritoneal covering of the uterus, such lesions are more abundant in that situation.

Under the designation *metritis dissecans,* Garrigues described a variety of severe puerperal infection in which not only the endometrium, but also a varying amount of the muscularis undergoes necrosis, and is expelled in large shreds or even as a cast of the interior of the uterus. As Schmidlechner suggests, it should more properly be designated as gangrene of the uterus. The condition was carefully studied by Rotthaus in 1927, and the student is referred to his article for the more recent literature.

It has already been stated that in most cases of infection due to the gas bacillus, or Bacillus welchii, the process is limited to the interior of the uterus. In other cases, the bacilli make their way into the muscular wall of the uterus, and at the same time invade the lymphatics and blood vessels, thus producing a general septicemia. Wherever the gas bacilli are arrested in the tissues they give rise to gas formation, which leads to the production of gas cysts, as well as to extraordinary dissociation of the tissue. Figure 727 represents a section through the uterus of a patient dying from generalized gas bacillus infection, and gives an excellent idea of the extent to which its muscular wall had become dissociated.

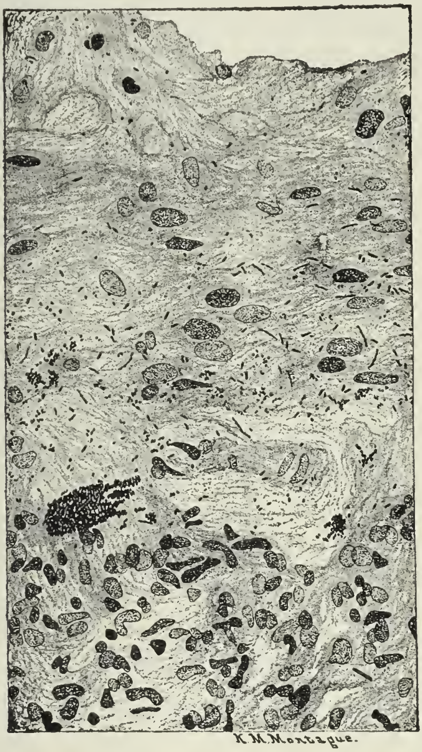


FIG. 725.—COLON BACILLUS ENDOMETRITIS. LEUKOCYTIC WALL NOT INVADED BY BACTERIA. × 800.

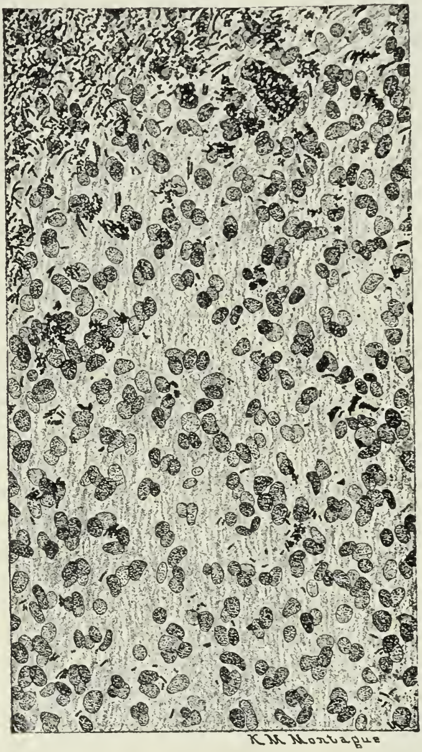


FIG. 726.—STREPTOCOCCUS ENDOMETRITIS, SHOWING INVASION OF LEUKOCYTIC WALL. × 800.

Peritonitis.—In the relatively rare cases of puerperal infection which end fatally, death is usually due to general peritonitis. As was pointed out when considering the histological changes in puerperal endometritis, the streptococci or other infecting agents may rapidly make their way by means of the lymphatics from the interior of the uterus to the peritoneal surface and there give rise to inflammatory changes. This is the usual mode of infection, but in rare instances it is said to be due to the escape of pus from the fallopian tubes; though in none of the autopsies which I have witnessed has such a mode of origin been observed. In general, it may be said that the process is gonorrheal in origin when the infection spreads by means of the tubes. Occasionally, peritonitis may follow the rupture of a parametritic or ovarian abscess, while in other cases it may result from instrumental perforation of the uterus or vaginal culdesac during criminal abortion.

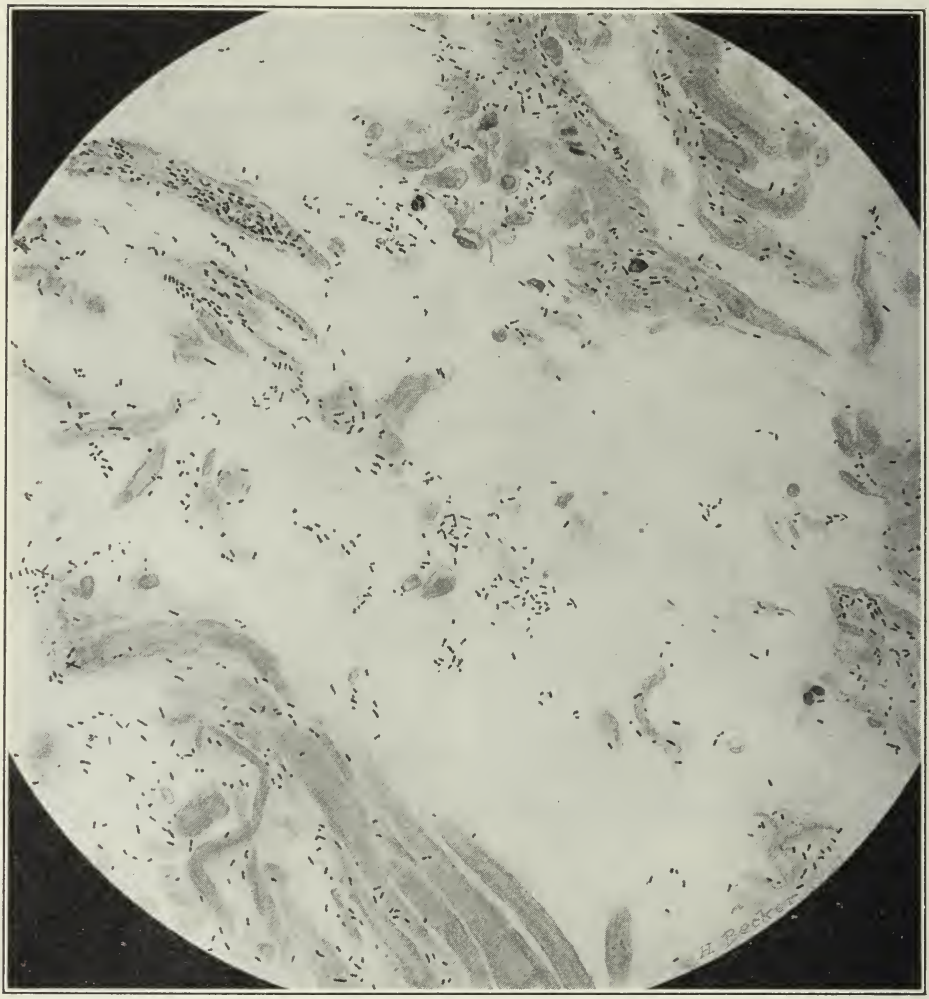


Fig. 727.—Changes Produced by the Gas Bacillus in Uterine Musculature. These include muscle disorganization and formation of gas cysts.

Salpingitis.—Very exceptionally, the infectious process extends directly from the uterine cavity to the fallopian tubes, and there gives rise to various inflammatory phenomena. Occasionally the salpingitis is due to infection through the lymphatics and in such cases the tubal mucosa is not involved. In most instances of streptococcus infection, the process does not extend to the tubes, but when they are involved the lesions are more marked at their lateral ends, thus indicating that the infection is secondary to the peritoneal involvement. Sometimes an *oöphoritis* occurs, the ovaries being enlarged to several times their usual size and very edematous. The process may stop here or go on to typical abscess formation. The ovarian infection is usually due to lymphatic involvement, and may be associated with affections of the parametrium. Much more rarely it results from direct infection of a ruptured follicle by means of the peritonitic fluid.

Parametritis.—One of the more frequent complications of uterine infection is parametritis. This usually follows infected tears of the cervix, but in other cases is secondary to a puerperal endometritis; in either event it is due to the transmission of the micro-organisms through the lymphatics to the periuterine connective tissue. The first effect of their invasion is an inflammatory edema, with little or no suppuration. In mild cases the process goes no further, but in the severer types it rapidly spreads to the surrounding connective tissue and eventuates in abscess formation. Frequently, the abscess is very large, dissects the peritoneum off from the anterior pelvic and abdominal wall, and eventually points over Poupart's ligament. Less frequently the process spreads posteriorly beneath the peritoneum, giving rise to *retroperitoneal phlegmons,* which may extend as high as the posterior mediastinum. In still another class of cases the bacteria follow the lymphatics in the connective tissue surrounding the greater vessels of the thigh, and give rise to a rare form of phlegmasia alba dolens, the usual variety being due to the direct extension of a thrombotic process originating in the uterine veins.

Pyemia.—The pyemic or thrombophlebitic form usually results from the infection of thrombi at the placental site with subsequent development of inflammatory changes in the veins. The thrombosis may be limited to a comparatively small area and be entirely within the uterine wall. In this event, the thrombosed vessels break down and give rise to small but multiple abscesses, scattered through the uterine wall. More commonly, the process extends beyond the uterus, involving the internal iliac or ovarian veins, or both, so that occasionally all venous trunks leading from the pelvis are thrombosed as far up as the junction of the renal veins with the inferior vena cava. Its mode of production was exhaustively studied by Bardeleben in 1907.

By the breaking down of the thrombi, small particles escape into the circulation and are carried by the blood current in various directions, giving rise to endocarditis and *metastatic abscesses,* from which no portion of the body appears to be exempt. In this thrombophlebitic form of infection, such abscesses may develop in any of the internal organs, the synovial surfaces also being frequently implicated and giving rise to swellings about the joints, which, if not promptly treated, may lead to their complete destruction. In other cases blebs or *bullæ,* due to the same cause appear on the surface of the body, and in their contents the offending micro-organisms are readily demonstrable. Less frequently, detached particles of thrombi may be arrested in one of the larger vessels of the lungs and give rise to pulmonary embolism and almost instantaneous death. When smaller vessels are involved the results are not so serious, though the portion of lung supplied by them becomes infarcted and gives rise to a secondary pleurisy or pneumonia, which may ultimately lead to death. It would appear from the observations of Mahler, Breuer, and Richter that a large part of the pulmonary affections occurring in puerperal women originate in this manner, and in not a few instances the appearance of a localized pleurisy may be the first manifestation of serious thrombotic process. In most cases of pyemia the clinical course is very prolonged, so that the patient does not die until six to twelve weeks after labor, when death is due to general exhaustion following a prolonged suppurative process. Consequently, at autopsy, the uterine mucosa may be found to be completely regenerated, and without a trace of inflammation, and the only indication that the process had originated in the uterus will be afforded by a few thrombosed veins.

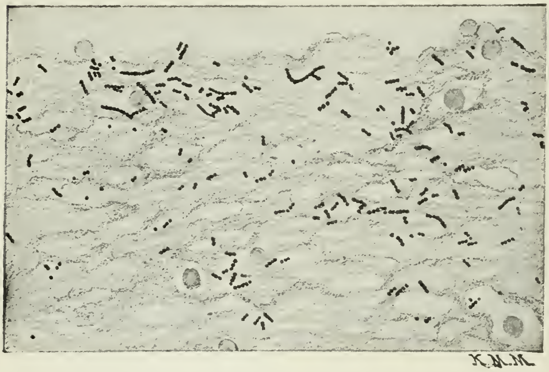


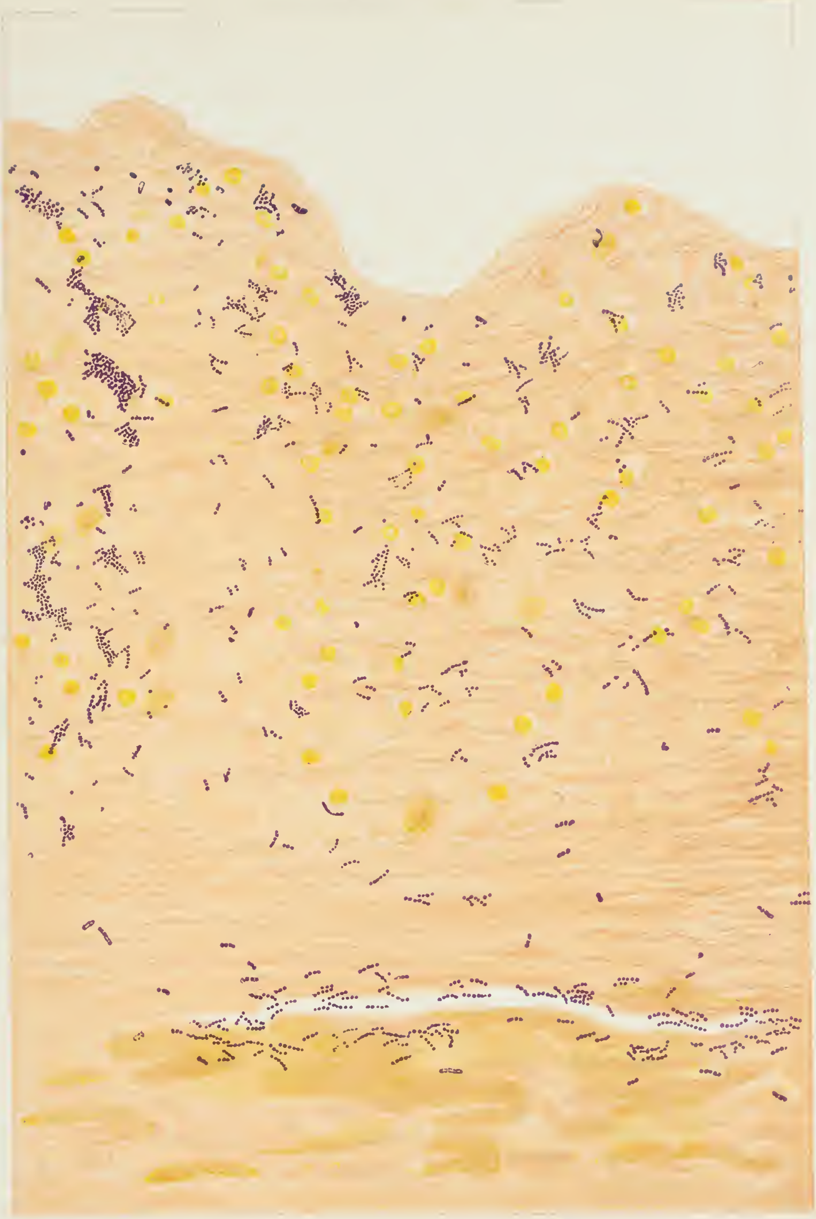
FIG. 728.—SECTION THROUGH THROMBOSED PELVIC VEIN, SHOWING STREPTOCOCCI. × 800.

Phlegmasia Alba Dolens.—As was pointed out when considering the question of parametritis, this affection, which is commonly designated as milk-leg, is sometimes due to the extension through the lymphatics of a parametritic process to the tissues surrounding the great vessels of the thigh. As a rule, however, it results from the extension of a thrombotic process from the pelvic veins; and in several of my autopsy cases the thrombophlebitis could be traced from the uterus to the common iliac veins, whence it extended upward to the vena cava and downward through the external iliac to the vessels of the leg.

Occasionally, in cases which recover, the phlegmasia appears to be an isolated process, though it is probably only a part of a much more extensive thrombosis, which has escaped recognition. Moreover, it should be borne in mind that even widespread thrombosis may give rise to but slight clinical manifestations, as in one of my cases which came to autopsy, the femoral vein and all its branches were completely occluded, yet careful mensuration was necessary to detect any difference in the size of the legs.

Clinically, phlegmasia alba dolens should always be regarded as a mani-

PLATE XVII.



K. M. Montague, fec.

SECTION THROUGH ENDOMETRIUM IN STREPTOCOCCIC PUERPURAL INFECTION. × 1000.

festation of infection; although it is sometimes impossible to discover its origin. Thus, I have seen it develop in patients who had not been examined vaginally, and in whom the first elevation of temperature occurred during the course of the third week. In other instances it has developed during the second half of pregnancy in apparently normal women. Furthermore, F. C. Goldsborough has described a case of complete occlusion of the common iliac, external iliac, and femoral veins, which occurred in my service, and was clearly the result of pressure. The inference, however, that the process is not of infective origin, is not permissible unless the patient comes to autopsy and bacteriological examination demonstrates the absence of bacteria.

An idea of the frequency of the various lesions in fatal cases of puerperal infection may be gained from the following figures of Kneise, which were based upon the findings in 89 autopsies:

	Cases
Peritonitis	43
Thrombophlebitis	20
Pyemia	17
Parametritis	7
Sepsis foudroyante	2

Defensive Mechanism.—Hofbauer in 1926 directed attention to a protective cellular mechanism which probably plays a considerable part in coping with many infections and preventing them from extending beyond the uterus. He showed that in the connective tissue of the parametrium, just where it joins the uterine wall, many more clasmatocytes and lymphocytes are present during pregnancy than at other times, that they increase in number as it advances, and become much more abundant in the presence of early infection (Fig. 729). He believes in the first place that these cells act as macrophages which ingest and destroy the bacteria, and in the second place serve to increase the immunity of the tissues to infection.

Stieve, in 1929, confirmed these observations, and at the same time directed attention to changes which occur in the connective tissue of the uterine wall, with which those interested in the histological changes occurring during pregnancy have long been familiar. He points out that during pregnancy the connective tissue, particularly in the outer layer of the uterus, becomes more embryonic in type, and in addition to fibroblasts contains the several types of cells to which Hofbauer directed attention. He likewise states that they become much more abundant during the first days of the puerperium, when they act as scavengers and help in the removal of the products of involution, whereas in infections of moderate severity they act as phagocytes. Such observations are of great importance and afford a ready explanation for the fact that many infections which extend beyond the portal of entry do not become generalized.

Furthermore, the researches of Benda, Louros and Scheyer, and others apparently show that the cells constituting the several parts of the reticulo-endothelial system act as a second line of defence, and tend to destroy or render innocuous such bacteria as may have made their way through the uterus. Indeed, Louros believes that the efficiency of ergot in controlling the spread of infection is due less to the compression of lymphatic channels by the contracting uterine muscle than to its stimulating effect upon the reticulo-endothelial system. Time alone can tell how correct such suppositions may be, but in any event, they serve a useful purpose in indicating how complicated are the factors concerned in the destruction of bacteria and in the development of immunity.

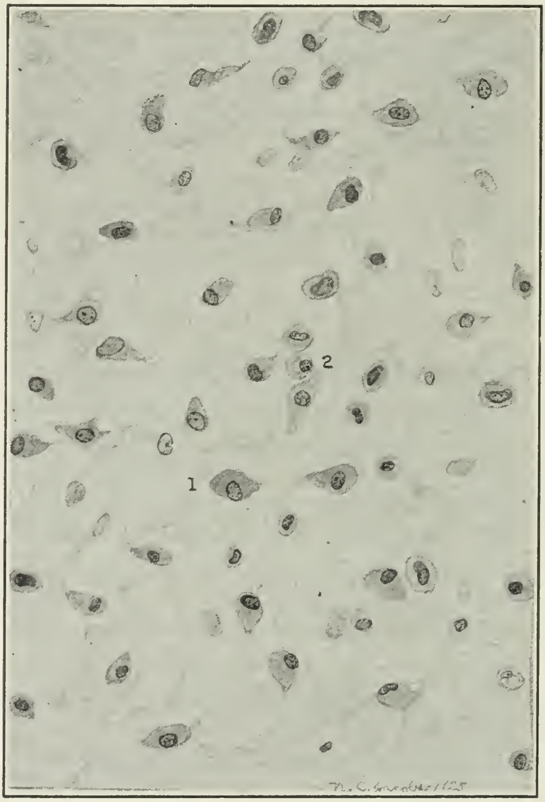


Fig. 729.—Hofbauer's Defensive Mechanism.
Showing clasmatocytes in parametrium.

Miller and Whitaker (1929) apparently show that the antibactericidal power of the blood increases progressively with the advance of pregnancy, attains its maximum at the time of labor, and falls rapidly during the first ten days of the puerperium. They are ignorant of its cause, but it is theoretically possible to associate it with the anatomical changes described by Hofbauer and Stieve.

Etiology.—As it has been conclusively demonstrated that the bacteria concerned in puerperal infection are identical with those with which we are familiar as causing ordinary wound infection, it must follow that puerperal infection is a wound infection resulting from the introduction of pyogenic bacteria into the generative tract either before, during, or immediately after labor. In other words, it is usually a direct infection from without, the bacteria being brought to the woman by the hands, instruments, or any other object which may come in contact with her generative organs.

Puerperal infection, then, is *contact infection,* this conception having been first definitely enunciated by Semmelweiss in the following words: "I consider puerperal fever, not a single case excepted, as a resorption fever, caused by the resorption of a decomposed animal-organic material. The first result of the absorption is a change in the blood, and the exudations are the result of this change. The decomposed animal-organic material, which, when resorbed, causes childbed fever, is brought to the individual from without in the great majority of cases, and this is infection from without. These are the cases which represent the epidemics of childbed fever. These are the cases which can be prevented."

In the latter part of the eighteenth century, puerperal fever began to be considered as a contagious malady in England. This conception apparently originated with Thomas Kirkland, of Ashby, in 1774, but was first clearly enunciated in 1795, by Gordon, of Aberdeen, in his treatise "On the Epidemic of Puerperal Fever, as it prevailed in Aberdeen from December, 1789, to March, 1792." In this he gave an account of 77 cases which he had attended, and, among other things, stated: "It is a disagreeable declaration for me to mention that I myself was the means of carrying the infection to a great number of women."

In this country we are mainly indebted to Oliver Wendell Holmes for introducing the conception of the infectious nature of the affection. In an article entitled "Puerperal Fever as a Private Pestilence," first published in 1843, he clearly showed that the epidemic form of the disease was preventable, and owed its origin either to the physician or midwife. His teachings, however, did not exert the influence which might have been expected, mainly because they were opposed by the leading obstetricians of the country, notably Meigs and Hodge. It should, however, be remembered that the major credit must always be given to Semmelweiss. Holmes wrote a scholarly paper, which was based upon inferences drawn from a study of the literature, whereas Semmelweiss' contribution was based upon his personal investigations. Furthermore, Holmes' suggestions for the prevention of infection represented merely the "counsel of despair," and consisted in advising the physician to abstain from practice for a time, to buy a new suit of clothes and to take a bath; whereas Semmelweiss introduced the use of a solution of bleaching powder for disinfecting the hands, and reported a striking reduction in the incidence of infection following its use.

For many years the prevalent theory in Europe was that puerperal fever was due to miasmatic, telluric, or atmospheric influences. This view held its ground for years after the appearance of Semmelweiss's book in 1861; although in 1864, Hirsch, after studying the matter from an historical standpoint, came to the conclusion that the malady was of infectious rather than of miasmatic origin. It was not, however, until after Lister had introduced antiseptic methods into surgery, and Stadfeld, of Copenhagen, had recommended the use of bichloride of mercury in obstetrics, that the great mass of the profession began to understand that puerperal fever is due to contact infection, and can be prevented to a very great degree. The bacteriological work of Pasteur and his successors, and the almost constant presence of streptococci in fatal cases, decided the question, and at present no one doubts the infectious nature of the disease.

Modes of External Infection.—The most usual mode of infection is by the hands of the obstetrician or the midwife, and no one who has observed the way in which many labors are conducted can wonder that puerperal fever occasionally occurs. The employment of dirty instruments, as well as dirty hands, also plays an important part.

Sources of infection, much rarer, it is true, but generally overlooked, especially among the lower classes, are self-inoculation by the patient fingering her genitalia or even making internal examinations, as well as by copulation during the latter days of pregnancy. Liepmann states that bacteriological examination of the prepuce of the penis reveals the presence of streptococci in 75 per cent of all cases; while I have seen several patients die, and a number of others seriously infected, who had not been examined internally, but who had copulated during the first stage of labor. Contact with wound secretion of any kind also plays an important part, and whether the purulent material be from an external wound or elsewhere within the body, the result will be the same. Wounds on the hands of the physician or nurse, bone felons, and other affections of the fingers, such as a pustular eczema, are sometimes responsible.

For years it had been known that puerperal fever often occurred when a woman in labor was cared for by a physician who at the same time was attending a case of erysipelas. As has already been said, some of the old authorities held that the two affections were identical, but it was not until bacteriology had proved that erysipelas, as well as puerperal infection, is due to the streptococcus that this relation was understood.

Puerperal fever has also frequently occurred in the practice of those attending diphtheria, scarlet fever, and occasionally typhoid patients. Although no essential relationship between these affections has been proven, it is well known that in both diphtheria and scarlet fever complications due to the streptococcus occur, and thus make possible their transmission to the woman in labor.

Air infection was formerly supposed to play an important etiological part, and in England, and to a less extent in this country, sewer gas was considered a possible cause. Following the dissemination of bacteriological knowledge, however, such ideas have gradually been abandoned. On the other hand, it is more than probable that those who carry hemolytic streptococci in their air passages may be distinctly dangerous to the lying-in woman. Following a serious epidemic of infection which occurred in the Sloane Hospital for Women in New York, in 1927, careful investigation by Meleny and Stevens failed to reveal any probable cause except air contamination by carriers among the medical and nursing personnel, and as a result, they recommended the wearing of masks by all who enter the delivery rooms in hospitals.

That our knowledge of the various possibilities for infection is still far from complete is shown by the fact that in our clinic the incidence of febrile puerperia varies materially with the social status of the patients, although all of them are delivered by the same staff, in the same delivery rooms, and with the same technic. Thus, they are rare in private patients, more common in the white ward patients, and much more common in the black ward patients. In 5514 ward patients delivered during the five years ending Sept. 30, 1929, 26.4 per cent of the blacks had a rise of temperature to 100.4 degrees on two or more days of the puerperium, as contrasted with 14.4 per cent of the whites—a ratio of nearly two to one.

To show how accurate a conception Semmelweiss possessed of the various modes of contact infection, it may be interesting to quote what he said concerning it: "The bearer of the decomposed animal-organic material is the examining finger, the operating hand, instruments, bed-clothes, atmospheric air, sponges, the hands of midwives or nurses which come in contact with the excrement of women sick with puerperal fever, and afterwards handle pregnant or parturient women. In other words, the bearer of the decomposed animal-organic material is anything which is soiled by a decomposed animal-organic material and comes in contact with the genitalia of these patients."

Auto-Infection.—At present it is universally accepted that the serious cases of puerperal infection are due almost without exception to the introduction from without of virulent streptococci into the genital canal of the pregnant or parturient woman. Nevertheless, many authorities teach that occasionally infection does not result in this manner, but owes its origin to bacteria which were already within the genital tract before the onset of labor. To infection arising in this way the term *"auto-infection"* is applied. The conception originated with Semmelweiss, who stated: "In rare instances the decomposed animal-organic material, which causes childbed fever when absorbed, is produced within the patient herself. These are the cases of auto-infection, and cannot be prevented."

With the enthusiasm which attended the introduction of antiseptic methods into obstetrics, the possibility of auto-infection was lost sight of for a time, and it was only after the statistics of well-conducted lying-in establishments showed that a certain number of cases of infection still occurred, despite the rigorous application of antiseptic principles, that the idea was rehabilitated by Ahlfeld, and Kaltenbach (1883-1889).

Of course, with the recognition of the fact that puerperal fever is due to bacterial infection, the definition introduced by Semmelweiss fell to the ground, since the bacteria could not originate spontaneously within the body of the woman. Kaltenbach then advanced the view that pathogenic bacteria are present in the vaginæ of a considerable proportion of apparently healthy pregnant women, and that these might make their way into the uterus, or be introduced into it by the sterile examining finger.

Apparent proof of such a possibility is afforded by the rare instances in which serious puerperal infection develops in women who had not been examined vaginally, and whose labors had been conducted in a thoroughly aseptic manner. Such cases undoubtedly occur, but even in them the proof is not convincing; as it is impossible to prove that the infection might not be due to the patient handling her genitalia, or to bacteria which were brought to the uterus by means of the blood current. Reference to the latter mode of infection has already been made in connection with the pneumococcus; and the streptococcus is sometimes similarly brought to the uterus in certain cases of angina, influenzal pneumonia, or other diseases. I was able to adduce convincing proof of its occurrence in influenzal pneumonia, by demonstrating the presence of chains of streptococci in arterioles making their way through the uterine musculature to the decidua.

Winter, in 1911, admitted the justice of these reservations, and held that one is justified in speaking of auto-infection only when bacteriological examination demonstrates that the bacteria found in the puerperal uterus had existed in the vagina at the onset of labor. He considers that he has been able to adduce such proof, and therefore holds that auto-infection undoubtedly occurs. Accordingly, the solution of the question will depend upon the results of bacteriological examination of the generative tract during the last weeks of pregnancy. Unfortunately, the investigations which have been undertaken for this purpose have not given uniform results, and consequently we are nearly as far from a scientific solution of the problem as when it was first broached; although in actual practice a constantly increasing number of obstetricians act as if auto-infection were impossible.

With the exception of Albert (1929) all investigators are united in claiming that the cavity of the normal uterus is free from micro-organisms both in the pregnant and non-pregnant condition. This fact was originally established by Gönner, Döderlein, and Winternitz in women, and by Strauss, Sanchez-Toledo, and Denzler in the lower animals, and has since been confirmed by many workers.

Prior to 1898, it was generally believed that the cavity of the normal puerperal uterus was also free from bacteria, and that their presence afforded indubitable evidence of infection. In that year, however, Franz stated that bacteria could frequently be found after the first few days of the puerperium in women who presented no clinical signs of infection. His publication was soon followed by others; some investigators stating that the bacteria in question were merely saprophytes, while others claimed that streptococci were frequently present.

In view of these contradictory statements, my former assistant, H. M. Little, investigated the question in 1905, and studied the uterine lochia obtained from 50 consecutive women delivered spontaneously in my clinic. In each case cultures were taken immediately after the expulsion of the placenta, and again on the third and ninth days of the puerperium. Not counting the gonococcus, the uterus was found to be sterile in 96, 85, and 70 per cent of the cases on each of the three days respectively, and in none of the 150 examinations were streptococci found.

In Little's studies only solid culture media were employed. So Harris and Brown, in 1927, took up the question again, making use of all types of culture media and utilizing the refinements of modern bacteriological technic. They took cultures from the uteri of 30 afebrile women on the fifth day of the puerperium, and found that 10 were sterile and 20 contained diphtheroids, but no streptococci of any kind. Consequently, in view of these investigations, it appears that the normal puerperal uterus is free from streptococci until after the fifth day, and if they are found before that time one has to deal with external infection, whereas later it is uncertain whether they are the result of infection from without, or of mere upward migration from the vagina.

In view of these investigations, it seems to me that the question of auto-infection must stand or fall with the demonstration of virulent streptococci in the vaginal secretion of healthy pregnant women. If they are even occasionally present, it must be admitted that they may be carried up into the uterus by the sterile examining finger, and give rise to infection; whereas if they are uniformly absent, such a contention must be dismissed as untenable. Unfortunately, the bacteriological investigations which have been undertaken to determine this question have served rather to complicate than to settle it; but my impression is that they tend to indicate that the presence of hemolytic streptococci in the uterus is rarely, if ever, the result of auto-infection, whereas that of other bacteria may be.

The monograph of Döderlein on the vaginal secretion, published in 1892, promised for a time to reconcile the conflicting opinions, but as his conclusions have not been confirmed by subsequent investigators, the question still remains an open one. He stated that the vaginal secretion may occur in one of two forms, which he designated as normal and pathological and which occurred in 55 and 45 per cent of his patients, respectively. The former was a thick, dry, cheeselike material of a whitish color and a distinctly acid reaction. Microscopically, it showed epithelial cells, a pure culture of tolerably long, thin bacilli, and occasionally a few yeast fungi. The pathological secretion, on the other hand, was fluid, generally of a yellowish color, suggesting pus, and sometimes contained gas bubbles. Its reaction was less acid than that of the normal secretion, occasionally neutral, and very rarely alkaline. In it were found large numbers of leukocytes and many micro-organisms of various kinds, both bacilli and cocci. As pyogenic bacteria were never present in the normal, while streptococci were noted in 10 per cent of the pathological secretions, he held that auto-infection was out of the question when the secretion was of the first, but might occasionally occur when it was of the second type.

Following Döderlein's investigations an immense literature has accumulated, but unfortunately the results obtained have been extraordinarily contradictory. Thus, Krönig, and I, in 1897 and 1898, respectively, stated that streptococci could not be found in the vaginal secretion of normal pregnant women; whereas other investigators found them in a varying proportion of their cases—the extremes being represented by 4 per cent in Burckhardt's series, and by 100 per cent in that of Natwig. Naturally, such radical differences indicate that neither side has correctly faced all aspects of the problem.

At one time, I thought that I had solved the problem, and that the contradictory results could be explained by differences in the technic employed for obtaining the secretion for examination. With this in mind, 25 normal pregnant women were studied, from each of whom three sets of cultures were made. The first set was taken from the inner surface of the labia minora by means of an ordinary platinum loop; the second set was made from secretion obtained from the upper third of the vagina by means of a Menge tube, while in the third set, after introducing a speculum into the vagina, the secretion was taken from beyond its free end by means of a platinum loop. Pyogenic cocci or colon bacilli were present in 80 per cent of the first, but were entirely absent from the second set, thereby indicating that the vaginal secretion, when obtained by a technic which precludes the possibility of contamination, is free from pyogenic bacteria. On the other hand, such bacteria were present in 48 per cent of the third set of cultures, which apparently showed that they had been carried up from the vulva by means of the speculum.

This explanation apparently settled the matter for a few years, but Bumm and Sigwart, in 1904, stated that my negative results were to be attributed to the employment of solid media, and had I used fluid ones many streptococci would have been found. They stated that by the use of such media they had been able to demonstrate the presence of streptococci in the vaginal secretion in from 38 to 74 per cent of a series of pregnant women, according as cultures were taken only once or upon several occasions.

Since then various other investigators have studied the problem, and as a rule have reported that streptococci could be found in a varying proportion of cases, Jötten, for example, having demonstrated them in 67 out of 100 women at the time of labor, and found that they were frequently of the hemolytic variety. He, however, attached no practical significance to their presence, as he held that they exerted no effect upon the course of the puerperium. He furthermore made the significant statement that the conflicting statements concerning their incidence were probably due to internal conditions in the various clinics rather than to errors in interpretation or in technic.

As I felt that it should be possible to discover at least a clue toward the solution of this complicated question, I requested Willa Fricke in 1914 to take it up once more, but I am sorry to say that, while she apparently discovered an explanation for certain phases of the subject, her findings added still further to the confusion. She studied the vaginal secretion in 50 women awaiting delivery in the clinic, employing the same technic as in my original work, but utilizing a greater variety of culture media—particularly glucose bouillon. She found streptococci upon the vulva and in the vaginal secretion in 14 and 8 per cent of the cases, respectively, and concluded that it made no difference whether it was obtained by means of a Menge tube or a speculum.

This 8 per cent incidence of streptococci was so small in comparison to that recorded by many German investigators, that it seemed important to attempt to ascertain the cause of the discrepancy. It was, therefore, tentatively suggested that the greater cleanliness of the patients in American hospitals might be a factor, and as a control, 47 outpatients were visited in their own homes without warning, and cultures were taken as in her first series. Streptococci were isolated from the vulva in 75, and from the vaginal secretion in 55 per cent of the cases, and approximately one-third of them were of the hemolytic type.

The difference between the two series is very striking, and indicates that streptococci were approximately seven times more frequently present in the latter, which is in close accord with the results obtained in the German clinics. As the only difference in the two series lay in the personal cleanliness of the patients, Fricke regards it as an important factor in explaining the incidence of streptococci, but we should hesitate to suggest that it constitutes the sole explanation. Fricke did not attempt to determine the virulence of the streptococci which she isolated, but the fact that none of the women in either series were seriously sick after delivery, and the further fact that the puerperium was afebrile in the 10 women whose vaginal secretion contained hemolytic streptococci, indicates that the cocci concerned were clinically harmless.

Reference has already been made to the greater incidence of febrile puerperia in black women, and the findings of Harris and Brown in their study of 113 cases of streptococcic infection bear out to some extent Fricke's conclusions. Thus, they found that the incidence of beta-hemolytic streptococci was practically identical in the two races, while that of the gamma types was four and a half times greater in the blacks. To be specific, the aërobic type was noted in 4 white and 15 black women, and the anaërobic type in 8 whites and 40 blacks. In other words, their results may be interpreted as indicating that when the beta-hemolytic streptococcus is isolated one has to deal with external infection, as contrasted with auto-infection in the case of the gamma streptococcus, and that the greater incidence of the latter in the black women has some connection with their lesser personal cleanliness.

In general, it may be said that the entire question of auto-infection is still *sub judice,* and that much additional work with modern bacteriological technic will be necessary before it can be settled. Tentatively, it may be concluded that while bacteriological research affords a certain amount of evidence in its favor, clinical observation speaks against it. Accordingly, the occurrence of serious infection due to the beta-hemolytic streptococcus should always be regarded as evidence of external infection. At the same time it is possible that auto-infection may occur from other organisms, which are present in the vaginal secretion, and plausibility is lent to such a supposition by the increasing frequency with which bacteria are found in the uterus with the advance of the puerperium.

The gonococcus forms an exception in this regard as it is the only pyogenic coccus which can live and thrive in the vaginal and cervical secretion. As already indicated, it is a frequent cause of puerperal endometritis. Such cases, however, should not be considered as supporting the doctrine of auto-infection, for the reason that they represent contact infections, which had occurred before conception or during pregnancy, after which the gonococci had led a parasitic existence in the crypts of the cervical canal, until they found suitable conditions for development during the first days of the puerperium, when they made their way up into the uterine cavity and manifested their presence by the production of fever and an increased discharge.

Likewise, one should not regard as auto-infection, in the strict sense of the word, those cases in which the bacteria are brought to the uterus from distant foci of disease by means of the blood current, nor those in which the process results from some preëxisting affection of the generative tract, such as an old pyosalpinx.

An interesting fact in connection with the question of auto-infection is that those who believe most firmly in its possibility, and who employ the prophylactic vaginal douche in the hope of destroying the vaginal bacteria, have been able to present less favorable statistics than their opponents. The same may be said concerning the employment of a 0.5 per cent solution of lactic acid as a prophylactic measure, with the idea that an increase in the acid titer of the vaginal secretion will lead to the destruction of pyogenic bacteria and favor the growth of the characteristic vaginal bacillus. This question was considered in detail by Hamm, in 1918. The value of prophylactic instillation of mercurochrome into the vagina is still *sub judice,* as the results of the study which I made during the year ending October 31, 1929, are not conclusive, and a still larger series of observations must be considered critically before a final judgment can be reached.

Frequency.—It is difficult to make accurate statements as to the frequency of puerperal infection, especially when it occurs outside of hospital practice. Concerning this condition the vital statistics of the health officers of the various American cities are of little value, inasmuch as many of the deaths from this disease are returned as being due to malaria, typhoid fever, pneumonia, or other causes. However that may be, it is generally admitted that the death rate from childbirth in the United States is higher than in any other civilized country in the world, and is estimated at between 6 and 8 deaths in every 1000 labors. Furthermore, Dublin in 1918, Woodbury in 1921, and Fränkel in 1924, stated that the deaths from infection made up 43, 40.2 and 37.7 per cent respectively, of the total number, and according to Woodbury, 7348 women died from this almost entirely preventable disease during the year 1921. Howard, likewise, calculated, in 1921, that 1 out of every 406 women who become pregnant dies from infection, and stated that "these rates are probably unparalleled in modern times in a civilized country."

Since the introduction of antiseptic methods into midwifery the mortality from puerperal infection has decreased very greatly in hospital practice. Formerly, in the old Maternity of Paris, and in the Lying-in Hospital in Vienna, it varied between 10 and 15 per cent, so that just before the dawn of the antiseptic era, steps were being taken to abolish such institutions as a menace to public health. With the introduction of aseptic methods, however, all this has changed, so that at present in well-regulated lying-in hospitals the mortality from infection is only a small fraction of 1 per cent, Pinard, in 1909, having reported a mortality of 0.15 per cent in 45,633 deliveries. Hence it happens that at the present time, in discussions upon the subject, so far as hospitals are concerned, the question is rather one of morbidity than of mortality, and deals with the percentage of patients whose temperature rises above 38° C., or 100.4° F., during the puerperium.

On the other hand, in private practice it is doubtful whether the results are materially better to-day than they were before the introduction of antiseptic methods, for the reason that the doctrines of asepis have not yet permeated the rank and file of medical men, and as a consequence in many localities, their results are worse than those obtained by midwives. Though, at the same time, it must be admitted that we rarely hear of outbreaks of puerperal infection such as were mentioned in the historical work of Hirsch.

Boehr, in 1875, stated that 363,324 women had died from puerperal infection in Prussia during the preceding sixty years, and calculated that every thirtieth married woman eventually perished from it; while Ehlers contended that outside of the well-regulated hospitals the results were equally bad in 1900. Furthermore, Fromme, in 1910, stated that at least 5000 women succumb each year in Prussia to this preventable malady.

Howard, and Eichel, in 1921 and 1922, respectively made important statistical studies and reached practically identical conclusions. The former studied the census figures for 1918 for the birth registration area, which included 53 per cent of the population, and found that one out of every 113 women delivered during that year died in childbirth—27.8 per cent from infection. He found that these figures were 120 per cent higher than in England and Wales, and then made the startling statement that, upon dividing the material according as the women lived in localities having ten thousand inhabitants or less, the incidence of infection was one-fifth higher in the urban than in the rural population.

Eichel studied the conditions obtaining in the State of New York for the five years ending with 1920. During that period he found that approximately one and a quarter million births had occurred, which were almost equally divided between the City and State of New York. In the former, one woman died in every 214 labors, while in the latter, the proportion increased to 1 to 151. He attributed the relatively good results in New York City to its well-conducted hospital facilities and to the presence of trained specialists. Upon analyzing more closely the figures for the State outside of the City of New York, he reached conclusions similar to those of Howard, and found that labor was considerably safer in rural communities than in cities and villages with more than 2500 inhabitants. In other words, he found that it was one-half again as dangerous to have a baby in the latter localities as in the City of New York, and one-fifth more dangerous than in the open country, where physicians were not always available.

Such figures seem to indicate that while preventive medicine has played a stupendous part in diminishing the incidence and mortality of infectious diseases in general, that of puerperal infection has not been affected, except in the largest centers where well-conducted lying-in hospitals and trained specialists are available. The figures of Howard and Eichel, which set forth the appalling conditions obtaining in the smaller cities and towns of the country, constitute a striking arraignment of our system of obstetrical training, and indicate that the rank and file of medical practitioners are no better trained than their predecessors, and consequently with the single exception of tuberculosis, puerperal infection still constitutes the most important cause of death among women during the childbearing period.

The investigations of Boxall, Byers and Lea show a similar condition in Great Britain, where it may be said that outside of the lying-in hospitals this preventable scourge claims as many victims as forty years ago. Eden, in 1922, pointed out that the mortality from childbirth had actually increased from 1911 to 1920, and that while the proportion of deaths from the complications of pregnancy and the accidents of labor had decreased, that from infection had actually increased.

Moreover, in attempting to ascertain the effects of puerperal infection, one cannot be guided altogether by the mortality statistics, inasmuch as the greater proportion of infected women do not die. On the other hand, no one who has to deal with gynecological patients can fail to be impressed with the very large proportion whose troubles have originated from febrile affections during the puerperium, which in most instances were due to the neglect of aseptic precautions on the part of the obstetrician or midwife.

Symptoms.—As was stated when considering the pathological anatomy of puerperal infection, the common lesion is an endometritis. This may be either of the septic, putrid or gonorrheal variety, each type presenting a group of more or less characteristic symptoms.

In the case of septic endometritis, after everything has gone smoothly for the first three or four days of the puerperium, the patient suddenly experiences some malaise, and complains of headache and a feeling of chilliness, or she may have a well-defined chill, the temperature rising to 103° F. or higher. Generally, only one rigor occurs, after which the temperature remains definitely elevated. At the same time there is some tenderness in the lower part of the abdomen, the uterus is larger and more doughy in consistency than it should be, and is sensitive on pressure. The lochial discharge is sometimes increased in quantity, is partly purulent in character, and may be practically devoid of odor. If the temperature is very high the secretion is usually diminished in amount, and may disappear almost entirely.

The character of the uterine discharges in these cases often leads to a mistake in diagnosis, as the average practitioner associates puerperal infection with foul-smelling lochia; whereas, in reality in the most virulent streptococcus cases.

there is very little, if any, odor, and its absence, therefore, is not necessarily a favorable indication, but rather the reverse.

Another point of importance is the faulty involution of the uterus. This must be looked upon as an important factor in the further spread of the disease, for the micro-organisms make their way through the muscular walls of the uterus by means of the lymphatics, and when the organ is much relaxed these channels are more patent and offer less resistance to the outward passage of the bacteria than when normal retraction is present.

The further history of septic endometritis varies according as the process remains limited to the cavity of the uterus or extends beyond it. In the former case the temperature gradually falls, the secretion becomes less and less, and the patient is slowly restored to health. The mucosa, however, is not restored to its normal condition at once, but for some time remains the seat of a subacute or chronic inflammation. When the process has extended beyond the uterus the symptoms will vary according to the organs involved, and those belonging to a parametritis, peritonitis, or pyemia, as the case may be, are superadded.

In putrid endometritis we may likewise have the initial chill and the high temperature, but the patient's condition does not usually appear so serious as in the septic form. The main difference, however, is to be noted in the character of the uterine discharge, which, in the putrid cases, is abundant, very foul-smelling, and frequently has a frothy appearance. These cases usually eventuate in recovery. Between these two well-marked types of cases, however, there exist all gradations, and not uncommonly we have to deal with a mixed infection due to pyogenic as well as putrefactive organisms.

In gonorrheal puerperal endometritis the symptoms are usually very characteristic. The first week of the puerperium is normal, and sometime between the eighth and tenth day, just as one is congratulating one's self that all is well, the temperature suddenly rises, usually without a chill, and remains elevated for a week or ten days, gradually falling to normal without treatment. Usually there is some abdominal tenderness and pain, which may become pronounced if the process extends beyond the tubes, which happens in only a small proportion of cases. In not a few instances, the diagnosis is facilitated by the development of the ophthalmia in the child several days before symptoms appear in the mother. Ordinarily only palliative treatment is required, and a few days additional rest in bed. Actual cure, however, rarely occurs, as the process tends to become chronic, and may lead to permanent sterility or to the development of chronic pelvic inflammatory disease, which may require operative interference months or years later.

The extension of the infection from the uterine cavity, or from cervical tears, to the parametrium produces an array of more or less characteristic manifestations. In many cases the initial rise of temperature lasts only for a few days, and we are congratulating ourselves that the patient has escaped so easily when suddenly another chill occurs, the temperature rises again, to pursue a more or less irregular course, usually marked by evening exacerbations. Within a few days vaginal examination or abdominal palpation will reveal the presence of a mass on one or both sides of the uterus, due to pus formation within the folds of the broad ligament. The abscess may be limited to this location, or, as it becomes larger, it may dissect off the peritoneum from the anterior portion of the pelvis and the abdominal wall, and form a tumor whose upper margin extends well above Poupart's ligament; in other cases, again, it extends backward toward the retroperitoneal region. Occasionally, in neglected cases, the pus may burrow beneath Poupart's ligament and form a large abscess under the fascia lata of the thigh. The fever continues until the abscess has been opened or ruptures spontaneously, except in the few instances in which it undergoes gradual resorption, leaving a mass of cicatricial tissue to mark its former situation. If not operated upon, a parametritic abscess may burst spontaneously into the rectum or bladder, and occasionally through the abdominal wall in the region of the inguinal canal. Unless it ruptures into the peritoneal cavity, the patient usually recovers after a prolonged illness.

After full term labor, streptococcic infections rarely extend from the uterine cavity to the fallopian tubes, and accordingly, if a salpingitis develops it is usually of gonorrheal origin. On the other hand, a considerable proportion of the cases of pyosalpinx following abortions are due to streptococci, and come to operation months later.

Unfortunately, it frequently happens that the infectious process does not remain limited to the uterus or to the parametrium, but the micro-organisms make their way through the lymphatics of the muscular wall of the uterus to the peritoneum, and there excite a *peritonitis;* though in exceptional instances the latter may result from the rupture of a parametritic ovarian, or tubal abscess.

Particularly in gonorrheal infections, the peritoneal implication is limited to the portion lining the pelvic cavity—pelvic peritonitis—but in streptococcic infections it tends to become generalized. In the former event, recovery is the rule, whereas in the latter death is almost inevitable. The characteristic symptoms of peritonitis usually make their appearance during the third or fourth day of the puerperium. If they occur at a later period the process is usually due to the rupture of an abscess.

When very virulent streptococci are the infecting agents the endometritic implication is usually very slight, and practically the first sign of infection appears from the side of the peritoneum. A definite rigor occurs, the temperature rises rapidly and remains constantly elevated, the pulse becomes rapid, and later on very weak and thready in character. The patient may complain of moderate pain, which is at first limited to the lower portion but gradually extends over the entire abdomen. At the same time there is marked tympanites, and the abdominal walls are rendered tense by the distended intestines. If a fatal issue ensues death usually occurs within ten days after delivery, the patient gradually sinking, although she usually remains conscious to the last. In other cases, however, the clinical symptoms do not correspond to the gravity of the lesion; the temperature is but little elevated, the pain slight, and the abdominal symptoms slightly marked, or even absent, the serious character of the condition being indicated only by the rapid and compressible pulse and by the drawn and haggard facies.

In the cases of *pyemia,* on the other hand, the clinical picture is very characteristic. Here the initial chill rarely occurs before the end of the first week, and the temperature does not remain constantly elevated but instead we have a typical hectic fever, with the chill, high temperature, and remission recurring in succession. The symptoms vary very considerably, according as one has to deal with the dislodgment of a single thrombus or of the repeated entry into the blood of small infected particles. In the first instance a metastatic abscess develops at some one point, the symptoms depending upon the organ involved. On the other hand, if thrombi are being constantly dislodged we may have symptoms referable to various organs.

One of the most constant manifestations of pyemia is an infectious bronchopneumonia, which contributes to the fatal termination. In other cases swellings occur at the various joints, which frequently eventuate in suppuration and lead to total destruction of the tissues implicated. Abscesses may also develop in the internal organs or appear upon the surface, and in several instances I have seen them lead to the destruction of the eye. The course of pyemia varies according to the organs attacked and the resisting powers of the patient, and weeks, or sometimes months, elapse before death occurs or recovery ensues. In general, it is less fatal than the peritonitic form of infection, but unless prompt resource is had to surgical intervention, its mortality is in the neighborhood of 60 per cent.

In rare instances the infection is so virulent that the bacteria do not have a chance to become localized in any one organ, and both they and their toxins are found in abundance in the circulating blood, with very slight implication of the uterus. This results in the so-called acute *septicemia*—the sepis foudroyante of the French writers—which represents the most rapidly fatal form of infection, the patients occasionally dying on the second or third day after delivery in a condition of shock, and without the development of local symptoms. A case of streptococcus septicemia, originating in our outpatient department, ended fatally within eighteen hours after the initial rise of temperature.

Occasionally, in acute gas bacillus infections, a peculiar train of symptoms may develop, as has been pointed out by Fraenkel, Brütt, and Sommer. The temperature is not very high, but in a day or so pronounced jaundice develops, the patient takes on a peculiar cyanotic appearance, becomes very torpid and hemoglobinuria appears to be soon followed by death. In one of my cases the symptoms were so misleading that acute yellow atrophy of the liver was suspected, and the suspicion was apparently confirmed by the demonstration of leucine and tyrosine in the urine and by a great increase in the nonprotein nitrogen content of the blood. Yet at autopsy, the peritoneal cavity contained a dirty brownish fluid, and air bubbles were escaping from minute openings upon the external surface of the uterus, resulting from the rupture of gas cysts. Figure 727 represents the disorganized structure of the uterine wall, while the products resulting from the breaking down of tissue explain the peculiar chemical findings, and possibly afford a partial explanation for the intense shock from which the patient suffered.

Occasionally, the thrombotic process involving the pelvic veins may extend to the femoral, and sometimes to the saphenous, vein on one or both sides, giving rise to *phlegmasia alba dolens*. This accident, as a rule, does not make its appearance until some time in the second or third week of the puerperium, or even later, the first symptom being pain along the course of the involved vessels, which, in thin individuals, may be felt as hard, sensitive cords. At the same time edema appears in the feet and soon extends upward, though occasionally it may appear first in the thigh. This swelling is associated with severe pain, and usually lasts for a considerable time, months sometimes elapsing before the patient can walk with comfort. The condition is rarely fatal unless some complication occurs. At the onset of phlegmasia many patients complain of severe pain about the chest. This symptom is attributed by Pinard and Wallich to the arrest of minute emboli in the smaller vessels of the lung, with subsequent infarction and the development of isolated areas of pleurisy.

In a certain number of cases infection may occur before the birth of the child. This is designated as *intrapartum infection,* and usually occurs in slow labors in which the membranes have ruptured prematurely. In such circumstances the temperature may be markedly elevated and the patient present a profoundly septic appearance even before delivery. When the temperature during labor rises above 100.5° F., we should always think of this complication, and at once institute procedures to hasten the evacuation of the uterus in the hope that the process will be limited to the cast off membranes and will not invade the uterine wall.

Diagnosis.—The diagnosis of puerperal infection is usually made without difficulty, as the clinical history is very significant.

If a patient, who has been doing well after delivery, has a rise of temperature on the third or fourth day exceeding 100.4° F. (38° C.), which persists for more than twenty-four hours, we may be practically sure that we have to deal with an infection, unless some other perfectly apparent condition will account for the symptoms. The occurrence of an initial chill adds to the probability of the diagnosis. In the old times it was believed that the onset of the lacteal secretion was accompanied by fever, and the older observers were always ready to attribute a rise of temperature on the third or fourth day to this cause. At present, however, this so-called *"milk fever"* is no longer regarded as a morbid entity, as we know that the normal puerperium should be afebrile.

In uncomplicated cases of puerperal endometritis usually very little pain is complained of, and it is sometimes difficult to decide whether the temperature is due to a uterine infection or some other cause. After the infection has become well established, either as an endometritis, or one of the other forms, the diagnosis is generally easy, and it is hardly possible to mistake the symptoms produced by a peritonitis or by a pyemia. In the cases of parametritis and suppurative affections of the tubes and ovaries, bimanual examination will demonstrate the presence of a mass on one or other side of the uterus, if the tumor has not already made itself evident to abdominal palpation.

Occasionally a febrile movement may occur between the seventh and fourteenth days, which may possibly be ascribed to *emotional causes,* such as excitement, fright, or grief. In this event the temperature may rise suddenly, and after reaching a considerable height promptly fall to normal within a few hours. Such a diagnosis is not permissible if the temperature remains elevated for more than four hours. Now and again a somewhat similar rise is caused by *auto-intoxication from the intestinal tract.* The diagnosis, however, is readily arrived at by the administration of a purgative, for after a copious movement of the bowels the temperature falls rapidly and remains normal. Again, fever occurring in the early part of the puerperium is sometimes due to inflammatory troubles about the breasts, but the subsequent history of the case readily clears up the question of diagnosis.

In addition to the conditions just mentioned, many intercurrent diseases may be accompanied by chill and high temperature temporarily making one suspect puerperal infection, although the subsequent history shows that one's fears have been groundless. This is frequently so in angina, acute pulmonary affections and pyelitis. Occasionally prolonged suppurative processes in other parts of the body may be accompanied by symptoms which may be confounded with puerperal infection, but in the present state of our knowledge there is no reason why we should long remain in doubt as to the cause and origin of the fever in a given case.

In the past malaria and typhoid fever were frequently confounded with puerperal infection, and were often made the scapegoat to shield the practitioner who had neglected proper precautions in the conduct of his case. While there is no doubt that either affection may occur during the puerperal period, in the vast majority of cases the diagnosis is open to question. If the symptoms be due to malaria one should be able to demonstrate the presence of the specific parasites in the blood.

In the past the diagnosis of typhoid fever was frequently made in prolonged cases of puerperal infection, being based on the long-continued fever and the general prostration of the patient, but in the present state of our knowledge such a diagnosis is not justified unless a positive Widal reaction can be demonstrated. On the other hand, typhoid fever complicating the puerperium may simulate very closely a puerperal infection. Jung has described several cases in which the true nature of the malady was not discovered until autopsy, and I have had a similar experience. Likewise, an acute miliary tuberculosis, or the flaring up of a chronic process during the puerperium, may occasionally simulate an infection, or may mask its symptoms.

To sum up, it may be said that it is a safe rule to regard every rise of temperature occurring in a puerperal woman as due to infection until it has been demonstrated that some other satisfactory cause is responsible. Hence it follows that, in making a diagnosis of any febrile affection complicating the puerperium, an accurate and complete physical examination of the patient is necessary, in which should be utilized all the aids which the recent advances in diagnostic methods have placed at our command.

Bacteriological Examination of the Lochia.—As the most common lesion in puerperal infection is an endometritis, it is a matter of scientific interest and some practical importance to decide whether one has to deal with the septic, putrid or gonorrheal variety; but, although in many cases the clinical symptoms will give tolerably definite indications, a positive conclusion can be arrived at only after a bacteriological examination of the uterine lochia. In gonorrheal infections the development of a purulent ophthalmia on the part of the child justifies a positive diagnosis, but even in such cases one is not sure that other organisms may not be concerned.

Cultures may be taken from the interior of the uterus with comparatively little difficulty by means of a simple device first introduced by Döderlein and modified by H. M. Little. This consists of a glass tube 20 to 25 centimeters in length and 3 to 4 millimeters in internal diameter, with a slight bend at one end so as to conform to the anteflexed condition of the uterus. It is threaded with a piece of strong silk, to one end of which a folded rubber band is attached, which exerts suction when traction is made upon the free extremity protruding from the other end of the tube.

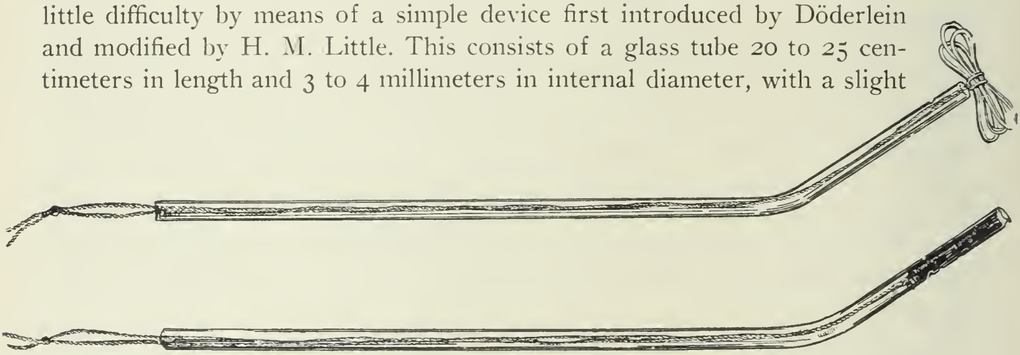


Fig. 730.—Little's Tube for Obtaining Uterine Lochia.

When cultures are to be made the necessary instruments and lochial tube are sterilized by boiling, and the hands of the operator and the external genitalia having been thoroughly disinfected, the patient is placed in the Sims or dorsal position and the cervix exposed by a suitable speculum. It is then seized with a volsellum forceps and, its vaginal portion having been carefully cleansed with a bit of sterilized cotton, the lochial tube is introduced as far as possible into the uterus, care being taken to avoid touching the external genitalia with it during the manipulation. On making traction upon the thread protruding from the free end of the tube, a partial vacuum is created and a certain amount of lochia is drawn up. The tube is then removed from the uterus and its ends hermetically closed with sealing-wax. After being taken to the laboratory, it is broken in its middle portion and cultures are made from the contents (Fig. 730). This method can be readily carried out by any practitioner, who is conversant with the ordinary rules of surgical technic, and if the tube be sent to a competent bacteriologist, it can be determined within twenty-four hours to what type of bacteria the infection is due.

In my practice this procedure forms a part of the routine examination in every puerperal patient presenting a rise of temperature above 101° F., and lasting for more than twenty-four hours. It gives most reliable information if employed during the first five or six days following delivery, but later the results are not decisive; as we now know that after that period bacteria practically always wander up into the uterine cavity from the vagina. I consider that this technic is preferable to the examination of the vaginal lochia obtained by means of cotton swabs, as recommended by many German authorities, since it gives precise information concerning the bacterial contents of the uterine cavity, while the latter method necessitates the inference that the uterine and vaginal flora are identical, which is by no means always the case.

As has already been indicated, it was for a time believed that the demonstration of the presence of hemolytic streptococci always indicated the existence of a virulent infection. This, however, is incorrect, as such bacteria may give rise to benign infections, or may even be present in healthy women. In general, it must be admitted that they are more frequently associated with serious infections than the nonhemolytic variety. On the other hand, their presence does not necessarily imply that the patient is in great danger; as in 90 instances in which beta-hemolytic streptococci were isolated from the uterine contents, during the five and one-half years ending October 31, 1929, only 5 deaths occurred—or once in 18 cases.

It has been objected that the examination of the uterine lochia may lead to erroneous conclusions, as it may give negative results, while at the same time bacteria can be cultivated from the blood. In my experience, however, this is not the case early in the puerperium; but in certain prolonged cases of pyemia, the uterine lesion may become completely healed and yet the patient may perish from extension of the thrombophlebitic process. In such an event, it is possible that the uterine contents may be sterile, while bacteria can be cultivated from the blood.

For diagnostic purposes, I rarely make blood cultures, except in two classes of patients, namely those admitted late in the course of the infection, or in those in whom serious symptoms do not develop until after the sixth day of the puerperium when we know that the results of bacteriological examination of the uterine lochia will be inconclusive. Furthermore, the demonstration of bacteria in the circulating blood is not necessarily of serious prognostic report, as they are frequently present in patients who are only slightly sick, although their presence on repeated examination does add materially to the gravity of the prognosis. Moreover, it should be remembered that in the thrombophlebitic form of infection, positive results can be obtained only when blood is withdrawn as the temperature is rising or at the time of the chill, whereas they are uniformly negative during the remissions. On the other hand, in infected abortions, bacteria can usually be demonstrated in the blood if the culture is made directly after the uterus has been emptied, while they are absent at other times. In such circumstances, a positive result has no practical significance.

The macroscopic appearance of the lochia is also of considerable value, for in putrid endometritis the discharge is frothy and frequently very offensive in odor, while in pure streptococcic infections it is very little changed from the normal. This distinction needs to be especially emphasized, since the first question which the practitioner usually asks in the presence of fever during the puerperium is whether the lochia are foul-smelling, and if he receives a negative answer he is too apt to think that the fever is of other than uterine origin. As a matter of fact, the reverse is almost constantly true, and, as a rule, the foulness of the odor is in inverse proportion to the danger to which the patient is exposed.

Prophylactic Treatment.—In considering the treatment of puerperal fever, prophylaxis should occupy the most important place. As has been repeatedly insisted, it is a wound infection, due to the introduction of pyogenic microorganisms by the hands or instruments of the doctor or nurse. Hence, it follows that the most scrupulous asepsis immediately before and during labor is the means upon which we have mainly to rely to limit its occurrence. Every physician who conducts a labor case cannot feel too strongly his personal responsibility in this connection, and he fails to do his full duty to his patient unless he regards the rules of asepsis as carefully as when performing a capital surgical operation. In view of what has already been said concerning the possibility of "droplet" infection, it is important in hospital practice that the physician and nurses should wear masks in the delivery rooms.

As long as vaginal examinations are made, infection will occasionally occur, even though the carefully disinfected hand be covered by a sterile rubber glove. As it is impossible to disinfect the vulva thoroughly, it must inevitably happen that bacteria are carried up into the vagina from it with each examination, and it is therefore not surprising that infection sometimes occurs. For this reason vaginal exploration should be dispensed with as far as possible, and with this end in view the obstetrician should perfect himself in the methods of rectal and external examination.

All that has been said concerning the necessity of cleanliness and asepsis on the part of the physician applies equally well to the nurse, and in all her manipulations about the patient she should never forget her responsibility in this respect. Moreover, she should be forbidden to make vaginal examinations or give douches except at the direct request of the physician in charge.

In view of what has already been said concerning the practical unimportance of auto-infection, I strongly advise against the employment of the *prophylactic douche* as a routine procedure, believing that except when the vaginal secretion presents marked evidences of abnormality it does more harm than good. Concerning the value of the instillation into the vagina of mercurochrome and allied substances opinion is still divided, and I regret to say that the results of the comparative study made in our service during the year ending October 31, 1929, were so inconclusive that it will be necessary to study a larger series of cases before a positive decision can be reached.

During the second stage of labor, except when it is necessary to inspect the parts, the vulva should be covered with an aseptic pad. This is advisable not so much for fear of air infection, as to prevent the possibility of contamination from the patient's hands. The third stage of labor likewise offers many facilities for infection, and too much stress cannot be laid upon its proper conduct. Speaking broadly, the generative tract after the birth of the child should be regarded as a *noli me tangere,* unless an emergency, such as hemorrhage or an adherent placenta, necessitates the introduction of the hand. The recommendation that the cervix be inspected after every labor in order to detect tears with a view to their immediate repair, seems to me to expose the patient to risks of infection incommensurate with the benefits to be obtained. On the other hand, in hospital practice, such a procedure should follow all operative labors.

Another point in the prophylaxis of puerperal infection is to close with sutures immediately after the conclusion of labor all perineal wounds, unless the procedure is contra-indicated by profound exhaustion on the part of the patient, or by a very edematous condition of the tissues implicated. To save time, it is my practice to introduce the sutures immediately after the birth of the child, and while waiting for the expulsion of the placenta.

To recapitulate, the liability to puerperal infection will be materially lessened by the strict observance of the following: (1) the maintenance of strict asepsis by the obstetrician and nurse before, during, and after delivery; (2) the restriction of vaginal examinations within the narrowest limits possible; (3) the greatest possible utilization of abdominal palpation and rectal examination; (4) the omission of prophylactic vaginal douches; (5) the immediate repair of perineal lacerations which might otherwise offer foci for infection; and (6) regarding the genital canal of the puerperal woman as a *noli me tangere,* into which neither finger nor instrument should be introduced except in emergencies.

Curative Treatment.—The curative treatment of puerperal infection is a question concerning which there is much dispute, and it is probable that what is said here may be directly opposed to the usual practice of many physicians.

If a puerperal ulcer is situated about the vulva or on the lower portion of the vagina, it should be occasionally touched with pure carbolic acid or tincture of iodine, and the parts kept as clean as possible. If the repaired perineum breaks down and suppurates, the stitches should be removed in order that free drainage may be provided.

As puerperal endometritis is the form of infection most frequently encountered, its treatment is most important; unfortunately the directions for it differ widely and are often contradictory.

Whenever the temperature remains at 101° F. for more than twenty-four hours, unless a uterine infection can be excluded with a fair amount of certainty, a sample of lochia should be withdrawn and subjected to bacteriological examination. Except in unusual conditions, there is no necessity for giving a saline intra-uterine douche afterwards.

Curettage as a routine measure cannot be condemned too strongly, for the reason that in the most virulent infections there usually is nothing in the uterine cavity which can be removed, and its employment can only do harm by breaking down the leukocytic wall which serves to prevent the invasion of the deeper layers of the uterus by the offending bacteria. On the other hand, when the uterus contains a quantity of débris, its removal is quite as readily, and much more safely, effected by means of the finger. This teaching is directly contrary to that formerly given by many writers, although now, I am glad to say, much greater conservatism is practiced, and the dangers of curettage are generally recognized.

The routine use of intra-uterine douches containing bichloride or other disinfectants in the treatment of these cases is contra-indicated on several grounds. In virulent streptococcus infection, histological examination shows that the organisms have penetrated far into the tissues by the time the initial chill and rise of temperature occur. In these circumstances the germicidal fluid cannot penetrate the uterine wall sufficiently deeply to reach the bacteria, upon which the further spread of the disease is dependent.

How little penetration occurs was shown experimentally by Bumm. He soaked the liver of an animal dead of anthrax in a 1 to 1000 bichloride solution for thirty minutes, and then cut sections from it with a freezing-microtome. After cutting off about 1/10 of a millimeter, he inoculated the next section into a laboratory animal, which succumbed to anthrax, thus showing that the germicidal action had been exerted only upon the surface. If this be the case in the laboratory, where the tissues can be immersed in the antiseptic solution for any desired length of time, what effect can the transitory application of a few liters of weak bichloride solution have upon bacteria, which are imbedded in the depths of the decidua or even in the muscular wall of the uterus? Moreover, in putrid endometritis the employment of antiseptic douches is even less rational, as a few days rest in bed will usually be followed by spontaneous cure. If, however, a douche is needed, one of sterile salt solution will lead to a rapid fall of temperature and the amelioration of untoward symptoms.

In addition to these somewhat theoretical objections, there is this very practical one: namely, that the employment of antiseptics may in many cases do actual harm. Not a few cases of sudden collapse following the use of carbolic acid douches are on record, while in some instances intra-uterine injections of weak bichloride solution have been the direct cause of death. For example, at the autopsy upon a woman who was supposed to have died from puerperal sepsis, I found all the anatomical lesions of bichloride poisoning, so that, to say the least, it remained doubtful whether the infection or the treatment instituted for its relief was responsible for the fatal issue. Consequently, when these facts are taken into consideration, it would appear that the benefit to be expected from the employment of antiseptic douches is at least problematical, while the dangers are very real.

The same considerations likewise apply to the various other antiseptic agents which have been recommended from time to time. Nor am I inclined to place great confidence in the disinfectant properties of injections of alcohol; while the results thus far reported from the use of irrigations with Dakin's solution in the treatment of puerperal endometritis are not encouraging, and tend to indicate that the conditions are not identical with those obtaining in infected wounds in other parts of the body, in which such signal success has been obtained.

The results following the intravenous administration of mercurochrome and other chemical antiseptic agents have not been satisfactory, nor were the results reported by Piper very encouraging. Indeed, it may be said that such medication is unnecessary so long as the infection is limited to the uterus, and is practically useless when the process has extended beyond it.

In general, when the infection has given rise to a simple endometritis, the less one does, the better it is for the patient. Consequently, in such cases she is kept in bed until several days after the temperature has returned to normal. An ice-bag is applied to the lower abdomen at intervals, and a course or so of ergot is given in order to stimulate involution and to bring about such occlusion of the lymphatics as may possibly prevent the extension of bacteria through the uterine wall. At the same time, the patient should be exposed to the sun in the open air for as long as possible each day, be given an abundance of easily digestible food and large quantities of fluid. Alcohol in large doses is well borne, and appears to do good.

A word may be said concerning the administration of ergot. Bumm redirected attention to the observation made by Guérin, in 1858, that in many cases of infection involution of the uterus had taken place very imperfectly, and recommended the use of ergot. For this purpose, one-half dram of the fluidextract should be given four times a day for forty-eight hours, and a similar course repeated after an interval of several days if necessary. In my experience, such medication apparently does good, and certainly does no harm. On the other hand, if ergot is administered continuously over long periods it may lead to chronic poisoning, resulting in gangrene of the lower extremities. Sänger, in 1929, pointed out that such accidents are particularly prone to follow the use of gynergen (ergotamine), and collected a number of cases from the literature. It has already been indicated that Louros and Scheyer believe that ergot, in addition to its local mechanical action, has a specifically stimulating effect upon the reticulo-endothelial system and thus aids in preventing generalization of the infection.

In gonorrheal endometritis active treatment is not required at the time, since in the vast majority of cases the moderate rise of temperature associated with the onset of the disease soon falls to normal, and the patients recover spontaneously, or are left with a chronic endometritis and disease of the appendages, which can be treated more advantageously at a later period.

The results following the somewhat nihilistic method of treatment just outlined are, to say the least, quite as good as those obtained by more radical measures, and this contention is sustained by the experience of Krönig, Bumm and many others. By this means I lost only 5 out of the 90 cases due to the beta-hemolytic streptococcus, which were treated during the five years ending October 31, 1929. Moreover, there were only two deaths in the 113 cases due to streptococci of all types, whether hemolytic, nonhemolytic, viridans or anaërobic, which were studied in our service by Harris and Brown during 1926 and 1927, and in one of these the fatal issue was the result of eclampsia rather than of infection. At the same time, it is not desired to give the impression that streptococcic infections are devoid of danger, as they are often serious and occasionally fatal, and I am convinced that our very favorable results are in part attributable to the fact that many mild cases are included in our series, which might have escaped recognition except for the routine bacteriological examination of the lochia in all febrile cases. Nevertheless, our results would appear to indicate that too energetic treatment may do harm, and that a better outcome will follow rational conservatism.

If the process has extended beyond the uterus, and we have to deal with a parametritis or a localized pelvic peritonitis, cold or hot applications are called for according to circumstances. If it is not clear to what extent the process has progressed cold should be applied, in the faint hope that it may lead to a limitation of the process. On the other hand, when the lesion is well developed, heat is indicated with the idea that the increased hyperemia caused by it may hasten the "ripening" of the process, so that it will sooner become amenable to surgical intervention. On the other hand, if general streptococcus peritonitis develops, the prognosis becomes extremely grave, as no matter what treatment may be instituted the outcome is almost universally fatal.

A great deal has been written on the *operative treatment* of puerperal infection, nearly every prominent obstetrician and gynecologist having made some contribution to the subject. Every one is agreed as to the advisability of opening parametritic abscesses as soon as fluctuation appears rather than allowing them to rupture spontaneously. Occasionally in parametritis, on palpation a semifluctuant sensation is conveyed to the examining finger which may lead one to imagine that one has to deal with pus, whereas upon opening the supposed abscess through the vagina or abdominal wall, as the case may be, the tumor turns out to be an inflammatory exudate without pus formation, and only a small amount of serous fluid escapes. Fortunately, incision into such masses frequently gives as good results as if a considerable quantity of pus had been evacuated, just as happens in cases of cellulitis elsewhere.

When pus tubes or ovarian abscesses can be made out by bimanual palpation, their removal is indicated, for as long as they remain the patient will continue in a septic condition. At the same time it should be remembered that in streptococcic infections the bacteria may retain their virulence for long periods, so that abdominal operations are much more dangerous than at other times.

For this reason interference should be delayed as long as possible, and in the early part of the puerperium should be undertaken only when urgently indicated. Whether such conditions should be dealt with by laparotomy or by puncture through the vagina will depend upon the particular case. If they are freely movable, laparotomy should be performed; whereas if they are adherent and readily accessible from below, vaginal puncture with subsequent packing of the abscess cavity with gauze is to be preferred.

The chief point of discussion concerning the operative treatment of puerperal infection has been as to the advisability of removing the infected uterus. as well as of ligating or exsecting thrombosed veins in thrombophlebitis. Here the various surgeons take quite opposite views, the more radical advocating prompt removal of the uterus, while the more conservative do not regard it with favor.

For two reasons it would appear that *hysterectomy* is contra-indicated in the majority of cases. In the first place, if one operates at a period sufficiently early to prevent the extension of the process to other organs, many uteri will undoubtedly be removed from women who would have recovered spontaneously; on the other hand, if one waits until a later period, when other organs have become implicated, the operation only hastens the inevitable termination. Nevertheless, there is a restricted field for hysterectomy whenever the process has given rise to abscess formation within the uterine walls. Again, in a putrid endometritis, when all other attempts to check the disease have proved futile, the operation would appear to be justifiable, as well as the occasional instances in which the infectious process is associated with the retention of an abnormally adherent placenta, or of one which has been retained behind a myomatous nodule.

Lusk, in 1896, suggested that hysterectomy may sometimes be useful in the cases of pyemia in which infected thrombi are carried from the uterus to various portions of the body, giving rise to metastatic abscesses and to a hectic condition. As a rule, however, the thrombotic process has extended far beyond the uterus by the time symptoms appear, and consequently its removal is useless. Much more practical is the suggestion of Freund, Trendelenburg, and Bumm, that the thrombosed vessels be exposed by laparotomy, and excised or ligated distal to the thrombus, as may seem most expedient, just as is done in the case of infected thrombi complicating mastoid disease. In 1909, I reported five such operations with four recoveries and reviewed the literature up to that time; while Miller made a statistical study of the results of the operation up to 1916. Since then Lequex and Chomé, and Huggins have reported their results, and it appears probable that timely operation will reduce the mortality by one-half. I feel that I have saved the lives of several women by this procedure, but the great difficulty lies in deciding whether intervention is indicated in the individual patient. To those contemplating performing the operation for the first time, I would recommend the study of Konatski's wonderful atlas, in which the topography of the pelvic veins is strikingly illustrated.

Formerly the development of general peritonitis was considered almost uniformly fatal, and, therefore, in cases of this character the treatment was usually perfunctory. But Sourdille, Kownatski, Leopold, Boquel, and others have shown that recovery may occasionally follow after freely opening and draining the abdominal cavity. Cragin, and Köhler, on the other hand, reported that their results were not encouraging. In my experience good results are generally obtained when the infection is due to the gonococcus, but almost never when due to the streptococcus. In view, however, of the almost certainly fatal outcome of expectant treatment in the latter, such interference would seem justifiable in very exceptional cases.

In certain cases of infection following criminal abortion, Pryor, Robb, Sourdille, and others have reported encouraging results following wide incision of the posterior fornix and packing Douglas' culdesac with iodoform gauze. In many such cases serous or purulent fluid escapes from the incision, so that it would appear that the procedure may be of value in preventing a pelvic peritonitis from becoming generalized. In my experience this procedure has not appeared to exert an appreciable influence upon the course of the disease.

The prospects of coping more successfully with puerperal infection were greatly brightened in 1895 by Marmorek's announcement of the discovery of an *antistreptococcic serum.* Unfortunately, the results of serum therapy in puerperal infection have not proved satisfactory. In May, 1899, a committee of the American Gynecological Society, of which I was chairman, made an exhaustive report upon the subject, giving the complete literature and collecting all the cases treated by serum which had been reported up to that time. It was found that 352 cases had been so treated, with 73 deaths—a mortality of 20.74 per cent; while in the 101 cases in which the presence of the streptococcus had been demonstrated it was 32.69 per cent.

Following the report of our committee the general consensus of opinion has been that Marmorek's serum is practically useless in the treatment of puerperal infection but that its employment does no harm. Later work by Aronsohn, Tavel and others indicated that better results should follow the employment of a polyvalent serum, obtained by utilizing as many strains as possible of virulent streptococci, obtained from human sources, in immunizing the animal from which the serum was to be obtained. Experience, however, soon showed that such sera are of little use in the treatment of actual disease, although they were supposed to be of prophylactic value in preventing the development of infection. It was soon found that whatever value they possessed was not due to the neutralization of the streptococcus toxins, but rather to bringing about conditions which favor phagocytosis and increase the general immunity.

Following the recent advances in our knowledge of scarlet fever, the question of antistreptococcus serum has been taken up with renewed hope and vigor. Important publications have been made by Warnekros, Louros and Becker, by Bernard, Hubert, Lash and many others. While some of the writers are very enthusiastic, others believe that the new sera are of little or no therapeutic value.

In view of such contradictory statements, it is evident that an efficient serum has not yet been produced, so that at present little hope should be placed in this type of therapy.

Some hope was entertained that satisfactory results might be obtained by use of bacterial vaccines. Sir Almroth Wright, however, informed me that he had no such expectation as to streptococcic infections, although improvement might be expected in certain chronic cases due to the staphylococcus or gonococcus. A collective investigation by a committee of the American Gynecological Society in 1910, has served only to confirm his conclusions.

In 1928, Armstrong and Shaw made an interesting study concerning the prophylactic value of streptococcic vaccine, by comparing two series of 600 to 700 patients each of which were treated prophylactically with varying doses of vaccine, with a series of similar size in which no treatment was employed. They found no great difference in the morbid incidence in each of the three series, but as the lowest incidence was noted in the untreated one they felt justified in concluding that the vaccine in question was without effect.

In 1925, Besredka, in his monograph on local immunization, recommended that pledgets soaked in filtrate from a bouillon culture of streptococci obtained from the patient herself, be placed in the infected uterine cavity in the hope that the immunity would be so increased as to enable her to cope successfully with the bacteria within her tissues. In the only case in which I employed this procedure, the results were disappointing, and I am inclined to believe that its field of usefulness will be limited; for the reason that such treatment will rarely be necessary when the infection is limited to the uterus, whereas it will rarely be effective when the process has extended beyond that organ.

In general, it may be said that in my experience little treatment is necessary when the infection is limited to the interior of the uterus, and that when it has extended beyond it the treatment will depend upon the lesion which has resulted. In general septicemia little can be done except in the way of general supporting treatment, free exposure to the sun, an abundant diet, alcohol and forced fluids, both by mouth and by rectum, as well as by the rectal and intravenous administration of glucose solutions, and particularly by the employment of small blood transfusions every few days. Occasionally, such patients recover contrary to all expectations, and thus make one dubious concerning the significance of cures which are reported as following all types of intravenous medication.

In general streptococcus peritonitis, the outlook is uniformly poor no matter what may be done, although very exceptionally cure may follow surgical intervention. In thrombophlebitis, prompt cure sometimes follows early ligation of the thrombosed vessels, but when the process has extended well above the pelvic brim, intervention is useless. Even in the latter type of case, however, hope should not be abandoned, as under conservative treatment a small fraction of such patients eventually recover after a prolonged illness. All other cases, which eventuate in localized abscess formation, should be treated along general surgical principles, and the pus should be evacuated or the organ removed as the experience of the surgeon indicates.

In other words, my experience has taught me that in the treatment of puerperal infection the best results are obtained by a combination of the greatest conservatism with reasoned radicalism, and that the former is usually, and the latter rarely, indicated. Moreover, he who is best acquainted with the natural history of the disease will have the greatest respect for the capabilities of the *vis medicatrix naturæ,* and the greatest skepticism concerning remedies of all sorts until their value has been confirmed by conscientious observation, and he will not be keen to operate upon desperately ill women when he knows that by so doing he is destroying their last chance.

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CHAPTER XLIV

DISEASES AND ABNORMALITIES OF THE PUERPERIUM

We have already discussed in detail the more typical instances of puerperal infection. We shall now take up certain atypical varieties—tetanus, phlegmasia alba dolens, and cystitis—and shall then proceed to consider certain other diseases and abnormalities which may be encountered in the puerperium, but which are not due to the introduction of infective material into the genital tract. Thus, we shall find that fever, associated with constitutional disturbances, is frequently met with as the result of pathological conditions in the breasts, disorders of the intestinal tract, and in very rare instances may be due to emotional causes. Moreover, it must be remembered that Nature has not rendered the puerperal woman exempt from the various disorders from which she might suffer at other times.

Tetanus.—The undoubted development of tetanus during the puerperium, although a very rare occurrence, has been fully established by the researches of Chantemesse and Widal, of Heyse, of Rubeska, and of others, who have isolated the characteristic bacilli from the uterine lochia. Schneider, in 1925, was able to collect 111 cases from the literature. The infection usually follows gross errors in aseptic technic, especially during operative procedures. Thus, in several of the reported cases, it is recorded that the operator placed the forceps upon the dirty floor by the side of the bed, and afterward carried it directly to the genital tract of the patient. Occasionally, however, such an explanation cannot be adduced, as in an epidemic in the Prague Lying-in Hospital, the disease, in one instance at least, occurred in a woman who had not even been examined internally.

Tetanus follows abortion more frequently than full-term labor, and as a rule gives rise to untoward manifestations between the sixth and tenth days of the puerperium, and sometimes later, though in rare instances the first symptom has been known to appear before the completion of labor. The prognosis is very grave. All of the 20 patients mentioned by Rubesca succumbed, while Vinay and Schneider reported a mortality of 89 and 91 per cent, respectively.

Beyond affording means for temporarily controlling the symptoms, therapeutic measures are valueless, although the intralumbar injection of from 5 to 10 cubic centimeters of a 15 per cent solution of magnesium sulphate is efficient in suppressing the convulsive seizures. Thus far the results obtained from the employment of antitetanic serum have not been encouraging, although its prophylactic employment has been attended by excellent results. In view of the hopelessness of other lines of treatment, Pawlik and Rubeska removed the uterus in several of their cases, but without avail.

Thrombosis of the Vessels of the Lower Extremities.—Thrombosis occurring in the crural, saphenous, or popliteal veins—*Phlegmasia alba dolens*—is usually a manifestation of puerperal infection, and follows the direct extension of a thrombotic process from the pelvic veins; occasionally it results from a localized phlebitis or periphlebitis, and in very rare instances may be due to purely mechanical factors. Occasionally, it develops without warning in apparently normal pregnant women, and in such circumstances its etiology is not clear. The lumina of the large veins rarely undergo complete obliteration, so that the circulation, while markedly interfered with, is not completely shut off.

Symptoms do not usually make their appearance until the latter part of the second week of the puerperium, or even later. In most cases, following a normal or only slightly febrile puerperium, the first manifestation is pain in one leg extending along the course of one of the larger veins; this is soon followed by edema, which usually begins in the foot and extends upward, although occasionally it appears first in the neighborhood of the groin. The leg soon becomes much swollen, the skin being tightly stretched and presenting a glazed appearance, and pitting can be elicited only after prolonged pressure with the finger-tip. If the crural vein is implicated, a very sensitive cordlike structure can often be palpated just beneath Poupart's ligament and can be followed for a certain distance down the thigh.

The inflammatory changes are usually attended by some elevation of temperature, the pulse being more or less accelerated. High fever and a very rapid action of the heart usually indicate that similar processes exist in other portions of the body, and that the patient is suffering from a more generalized thrombophlebitis. In uncomplicated cases the pain, swelling, and temperature continue for several weeks, and then gradually subside, though usually months elapse before the patient regains the full use of the leg.

Ordinarily, the process is limited to one side, more rarely both extremities are affected, an interval of a week or ten days elapsing before the second leg becomes implicated. If properly treated, most cases undergo spontaneous cure, the condition being dangerous only when it forms part of a generalized process, or when the thrombus undergoes suppuration and softening, so that infected particles are carried to other parts, giving rise to sudden death from pulmonary embolism or to metastatic abscesses.

Treatment.—Complete rest is absolutely essential. The lower part of the leg, should be elevated, and the entire member encased in absorbent cotton and protected from the weight of the bedclothes by a suitable contrivance. If the pain is severe morphin may be required, though ordinarily the application along the course of the thrombosed vein of cloths soaked in lead water and opium is followed by marked relief. Painting the leg with a 15 or 20 per cent solution of ichthyol sometimes gives great comfort.

On account of the danger of detaching portions of the thrombus, the leg should never be massaged. The patient should be kept in a horizontal position for at least a week after the temperature has subsided, and for a time after being allowed to get up she should be cautioned against making sudden movements.

Small varicose veins of the lower extremities sometimes undergo spontaneous thrombosis during pregnancy, but more often during the first weeks of the puerperium. In pregnancy this occurrence is favored by the interference with the circulation due to the pressure exerted by the uterus upon the vessels returning from the extremities. During the puerperium its development may be incident to pressure exerted upon the intrapelvic veins by inflammatory exudates. This form of thrombosis is usually unattended by symptoms, although now and again the development of a localized phlebitis or periphlebitis may cause pain, and exceptionally eventuate in the formation of a small abscess.

Gangrene of the Extremities.—In very rare instances, as the result of extensive thrombosis of the venous channels or of embolism of the arteries, the circulation in the extremities may become so impaired that gangrene results. This accident, first described by Churchill and studied more particularly by Wormser and Burckhard, is a most serious complication, and usually ends fatally. Wormser, in 1904, collected 80 cases from the literature, 6 of which were apparently examples of Raynaud's disease, while of the remainder 66 cases occurred in puerperal, as compared with 6 in pregnant, women. The process usually involves one or both feet, although the hand or forearm may occasionally be implicated. Sixty-two per cent of the 34 patients mentioned in Lafond's thesis died, in spite of the fact that in several instances amputation was resorted to in order to check the further development of the process. In the preceding chapter, reference was made to the production of the accident by excessive medication with ergot.

Diseases of the Urinary Tract.—A *cystitis* occurring during the puerperium is usually the result of infection following catheterization, during which the rules of asepsis have not been scrupulously followed. The occurrence of the condition is favored by the presence of slight lesions of the vesical mucosa which frequently accompany easy and spontaneous labors, and are almost universally associated with difficult deliveries. In rare instances it results from the direct extension of areas of inflammation about the urethral orifice and vulva.

In view of the constant presence of bacteria in the normal urethra, and of the impossibility of thoroughly disinfecting the vulva and urethral orifice, cystitis will occasionally occur, despite the most rigid precautions. For this reason catheterization should be restricted to the greatest possible extent, and employed only when the patient is unable to evacuate the bladder after being placed in a sitting position. As a prophylactic measure, it is advisable to inject a few cubic centimeters of dilute nitrate of silver solution before withdrawing the catheter.

As the process demands a certain period of incubation, symptoms do not usually appear for several days. The patient first experiences a frequent desire to micturate, but passes only a small quantity of urine at one time, the act being accompanied by a burning sensation in the urethra and a tendency to tenesmus afterward. At the same time, the bladder and the urethra become sensitive on pressure. The urine is usually cloudy, and upon microscopic examination is found to be loaded with mucus, leukocytes, epithelial cells, and bacteria. Occasionally it contains a large proportion of blood. The acid reaction is usually retained, although, more especially when the process is prolonged, the secretion may become alkaline and very offensive in odor. Now and again cases are encountered in which the infection is so severe that larger or smaller portions of the mucosa become exfoliated and are cast off with the lochia, their expulsion being associated with cramplike pains.

In these virulent types, as well as in the milder but obstinate processes, the disease sometimes extends up the ureters and involves the pelvis of the kidney, giving rise to a *pyelitis,* which may be followed in a few weeks by a *pyelonephritis* or a *pyelonephrosis.* Thus, it sometimes happens that a patient, who had apparently recovered from a cystitis, may suddenly experience intense pain in one renal region, associated with the development of a fever characterized by marked remissions and the passage of large quantities of urine laden with pus. The condition frequently apparently passes off to recur again when least expected. It should, however, be remembered that such an association is lacking in most cases of puerperal pyelitis, in which the sudden appearance of high fever arouses fear that one has to deal with a uterine infection.

In mild cases of cystitis the *treatment* consists in the ingestion of large quantities of fluid, particularly milk and the carbonated and alkaline waters. The vesical irritability is often satisfactorily allayed by the administration of 10-grain capsules of hexamethylenamine repeated every four to six hours. Ordinarily, simple treatment leads to recovery in a comparatively short time, but if the process drags on, daily irrigation of the bladder with a 2 per cent solution of boric acid or a very weak solution of silver nitrate should be practiced.

In most cases of pyelitis the symptoms disappear after rest in bed and the administration of large quantities of fluids and enough sodium bicarbonate to render the urine alkaline; but experience teaches that the cure may be only apparent, as in a considerable fraction of cases urine obtained by catheterization of the ureters contains colon bacilli months or even years later. Whenever a pyelonephritis is accompanied by prolonged febrile manifestations, drainage and occasionally extirpation of the organ may be required, although this is fortunately rarely necessary.

Incontinence of Urine.—In multiparous women, during the early part of the puerperium, coughing, sneezing, or other factors leading to a sudden increase in the intra-abdominal pressure, often produce an involuntary discharge of a small quantity of urine. The condition usually passes off spontaneously, but cure is sometimes hastened by the administration of $\frac{1}{30}$ grain of strychnia four times a day.

More marked incontinence at this time is usually the result of lesions about the neck of the bladder following operative delivery, though when the condition does not manifest itself until late in the first week it may be the first sign of the development of a *vesicovaginal fistula*. In this event, scrupulous attention to cleanliness will frequently be followed by spontaneous recovery; but when the fistulous opening persists, a cure can be effected only by operative procedures at a later period.

Hemorrhages during the Puerperium.—Ordinarily, if there has been no serious loss of blood during the first hour or hour and a half following delivery, it may be assumed that the danger of postpartum hemorrhage has passed. Occasionally, however, in the latter part of the first week, and more often still later in the puerperium, more or less severe uterine hemorrhages are encountered. They are nearly always due to the retention of portions of a placental cotyledon or of a succenturiate lobule, which may have been overlooked at the time of labor. If the retained tissue is not cast off spontaneously or removed manually, it undergoes gradual necrosis, while at the same time fibrin becomes deposited about its periphery, giving rise to a polypoid growth of varying size—*placental polyp*—which so interferes with the involution of the adjacent portion of the uterus that bleeding continues so long as it remains *in utero*.

The retention of large portions of the fœtal membranes rarely gives rise to serious hemorrhage, as the tissues gradually disintegrate and are cast off with the lochial discharge. On the other hand, a relatively small portion of the decidua may fail to undergo the usual regressive changes, while the remainder of the mucosa regenerates normally. In such circumstances, the condition is designated as endometritis postpartum or postabortum, according as it follows full-term labor or abortion. For reasons with which we are as yet unacquainted, it interferes with the involution of the uterus, and may give rise to severe hemorrhage. Frankl described such conditions in 1926, and I have been surprised to find that a portion of decidua only a few millimeters in diameters may lead to serious consequences.

The diagnosis of the retention of a placental remnant or the existence of a polyp can only be verified by the sense of touch. Therefore, whenever a patient suffers from an acute loss of blood during the puerperium, the interior of the uterus should be carefully palpated, and any abnormal tissue promptly removed by means of the finger or curet. Moreover, when the retained portion is of any size, and particularly when it has given rise to fever, Couvelaire and his associates consider that the condition is best treated by hysterectomy.

The treatment of the slight hemorrhage following retroflexion and subinvolution of the uterus will be referred to under those headings. The loss of blood associated with an endometritis postpartum demands curettage. If the patient bleeds excessively after the expulsion of an hydatidiform mole, similar treatment is indicated. And, on account of the possibility of the development of a chorionepithelioma, the tissue removed should always be subjected to careful microscopic examination.

Puerperal Hematoma.—A tumefaction resulting from the escape of blood into the connective tissue beneath the skin covering the external genitalia or beneath the vaginal mucosa is known as a vulval or vaginal hematoma. This condition, first studied in detail by Deneux, in 1830, is a rare complication of labor and the puerperium, occurring about once in 1500 or 2000 cases. It occasionally originates during pregnancy, and may attain such proportions as to interfere with the descent of the child. Very exceptionally, if medical aid is not available, fatal hemorrhage may follow its rupture at the time of labor, as in the cases reported by Künzig and others. The condition usually follows injury to a blood vessel during the act of labor without laceration of the superficial tissues, and may follow spontaneous, as well as operative, delivery. Now and again it does not occur until later, and is then attributable to the sloughing of a vessel which had become necrotic as the result of prolonged pressure.

Less frequently the torn vessel lies above the pelvic fascia. In this event the hematoma develops above it, and in its early stages gives rise to a rounded or sausage-shaped tumefaction, which projects into the upper portion of the vaginal canal and may almost occlude its lumen. If the bleeding continues, it spreads apart the broad ligament and separates the peritoneum from the adjacent tissues. In this way the effused blood may form a tumor palpable above Poupart's ligament, or it may make its way into the iliac fossæ, gradually invade the renal region and eventually reach the lower margin of the diaphragm.

Vulval hematomata of moderate size are usually absorbed spontaneously. Occasionally the tissues covering the tumor may undergo pressure necrosis and give way, profuse hemorrhage resulting, or the contents may be discharged in the form of large clots. In either event the interior of the hematoma is very prone to become infected, the condition sometimes ending fatally. If the tumor is large, it not only causes discomfort by its mere size, but gives rise to great suffering, which, as the result of the tearing and stretching of the tissues, becomes more intense the more rapidly the hematoma develops.

In the subperitoneal variety, such quantities of blood may be effused beneath the peritoneum that the patient rapidly succumbs to acute anemia. In other cases, a fatal issue follows secondary rupture into the peritoneal cavity. Occasionally rupture occurs into the vagina, in which event the hematoma becomes infected, and the patient perishes if suitable treatment is not promptly instituted. In 33 cases of subperitoneal hematoma which I collected in 1904, the mortality was 56 per cent. It is interesting to note that more than 60 per cent of the cases occurred in primiparæ, and 71 per cent after spontaneous labor. In my patient the hemorrhage came from a vessel at the base of the bladder, which had become torn through during the course of a spontaneous labor.

A vulval hematoma is readily diagnosticated by the sudden appearance of a tense, elastic, fluctuating, and sensitive tumor of varying size, covered by discolored skin. When the mass develops in the vagina it may escape detection for a time, but the development of pressure symptoms soon leads to a vaginal examination, when a round, fluctuant tumor is found, which encroaches upon the lumen. On the other hand, when the hematoma extends upward between the folds of the broad ligament, it is liable to escape detection, unless it gives rise to a tumor which can be felt upon abdominal palpation, or unless symptoms of anemia or infection appear. In my case the uterus was displaced upward by the effused blood, and on bimanual examination a fluctuant tumor 15 centimeters in diameter could be palpated beneath it.

The prognosis is usually favorable, though very large hematomata occasionally lead to death from hemorrhage, whereas in rare cases the fatal termination is the result of infection.

Treatment.—Small hematomata should be left alone, as spontaneous, but low resorption usually takes place, provided the parts be kept clean and infection avoided. On the other hand, a steady increase in size indicates a continuance of hemorrhage, and in such cases the tumor should be laid widely open and packed with gauze, as it is rarely possible to isolate and tie the bleeding vessel. The strictest antiseptic precautions are imperative, inasmuch as infection is a frequent complication. In large subperitoneal hematomata, accompanied by acute anemia, laparotomy should be promptly performed, the blood clots removed, and the hemorrhage controlled by ligature or by packing the cavity with gauze.

Diseases and Abnormalities of the Uterus.—*Subinvolution.*—This term is used to describe an arrest or retardation of the process of involution, by which the puerperal uterus is normally restored to its original proportions.

Involution is the result of an autolytic process, which leads to atrophy of the individual muscle cells, rather than to fatty degeneration, as was formerly supposed. Its proximate cause is to be sought in the liberation of certain, as yet unknown, ferments associated with the sudden and marked diminution of the blood supply to the uterus. As this can be brought about only by satisfactory contraction and retraction of the organ, it is apparent that any interference with those functions may be followed by subinvolution.

Among the most frequent factors concerned in its production are imperfect exfoliation of the decidua, retention of portions of the after-birth, inflammatory lesions of the endometrium, the presence of myomatous nodules in the uterine wall, abnormalities of circulation which accompany displacements of the uterus, existence of pelvic inflammatory lesions, and insufficient rest during the puerperium. In other words, subinvolution is the result of local conditions and not of constitutional disorders. Accordingly, careful investigation will usually reveal the underlying cause, and appropriate treatment, if undertaken sufficiently early, will lead to its cure.

The existence of subinvolution is manifested by a prolongation of the lochial discharge beyond the usual period, and sometimes by profuse hemorrhage, its cessation being followed by persistent leukorrhea with pains in the back, a general feeling of dragginess, and a delayed return to perfect health. If the condition is not properly treated, it may lead to permanent changes in the uterus, and particularly in its vessels, which are sometimes associated with such persistent hemorrhage as eventually to necessitate the removal of the organ. According to R. F. Smith, and Otto Schwarz, such uteri are abnormally large, contain much more fibrous and less muscular tissue than normally, while the arterial walls are so altered that the normal mechanism for the regulation of the circulation is in abeyance.

The diagnosis is established by bimanual examination, the uterus being found to be larger, softer, and more succulent than it should be at a given time following delivery. Inasmuch as subinvolution is dependent mainly upon local conditions, very little can be expected from medicinal treatment, although the administration of ½ dram of the fluidextract of ergot every three or four hours, together with copious hot vaginal douches, for several days is sometimes followed by improvement. Local measures afford much better results. If the uterus is displaced it should be put in proper position by bimanual manipulation and held in position by a suitably fitting pessary. When disease of the endometrium or retention of portions of the after-birth is responsible, prompt curettage offers the most efficient method of treatment. On the other hand, procrastination may lead to serious results, as the subinvolution may become permanent.

Lactation Atrophy of the Uterus.—Ordinarily, in women who suckle their children, the uterus continues to involute after the completion of the puerperium, so that several months after delivery it may be smaller than in the virginal state. This condition is attributed to reflex irritation emanating from the breasts and incident to lactation and nursing. It usually disappears spontaneously after weaning, although when the child is nursed for a long period, the uterus may begin to increase in size after the fifth or sixth month, even though lactation continues. It is probable that the cessation of menstruation, which is usually observed during the early months of lactation, should be partly attributed to this form of atrophy.

Lactation atrophy was first definitely described by Jacquet, in 1871, and since the publication of his paper has been carefully studied by numerous investigators, particularly Thorn, Gottschalk, Döderlein, and Vineberg. In rare instances, it may persist after weaning and become permanent, the uterine cavity sometimes measuring only a few centimeters in length. This abnormality, first described by Chiari, Braun, and Spaeth, in 1855, was later designated by Simpson as *superinvolution.* It is probable that it may occasionally be an important factor in the production of subsequent sterility, as well as in the unusually early appearance of the menopause.

Displacements of the Uterus.—Immediately following the birth of the child, the lower uterine segment and cervix are represented by a flabby, collapsed structure which is freely movable upon the rest of the organ (see Fig. 341). In these circumstances a comparatively trivial cause, such as a slight increase in the intra-abdominal pressure or distention of the rectum, may lead to an excessive bending forward of the body of the uterus—*anteflexion.* The condition is usually without significance, but occasionally the angle formed between the upper and lower portions of the organ may be so acute as to occlude the cervical canal and lead to the retention of the lochial discharge—*lochiometra.* As a rule the retention, when it occurs, is only transitory, but if it be prolonged the lochia may undergo putrefactive changes, when the absorption of toxins may give rise to constitutional symptoms. The complication is readily overcome by allowing the retained discharge to drain away through a douche tube, after which the uterine cavity should be irrigated with sterile salt solution.

So long as the body of the uterus lies above the superior strait, retrodisplacement cannot occur, as the falling backward of the enlarged fundus is prevented by the promontory of the sacrum. But as soon as the organ has become sufficiently involuted to descend into the pelvic cavity a *retroflexion* or *retroversion* becomes possible. The development of such displacements, which are rarely observed before the third week of the puerperium, is probably connected with excessive relaxation of some of the structures about the base of the broad ligaments incident to overdistention by the presenting part, and in all likelihood is favored by undue laxness of the walls of the uterine isthmus. Doubtless, prolonged distention of the bladder may act as an accessory cause. It is important to remember that it is not due to negligence on the part of the obstetrician, nor is it by any means always due to trauma incident to operative procedures, as in my experience retroflexion quite as frequently follows normal spontaneous labor during which no apparent injury was sustained. In other cases the retroflexion merely represents a recurrence of a condition existing prior to pregnancy.

Backward displacement of the uterus rarely gives rise to symptoms so long as the patient remains in bed, but as soon as she begins to move about its presence is apt to cause more or less inconvenience. The earliest and the most characteristic manifestation is an increase in the amount of lochial discharge and its persistence for longer periods than usual. Sometimes the patient suffers from pain in the back and lower abdomen, although in other cases she may only be conscious that she is not regaining her strength as rapidly as she had expected. In many instances, however, the displacement does not give rise to symptoms, so that the patient may have no idea of its existence until it is detected during the course of a pelvic examination months or years later. In my experience such displacements occur in every fourth or fifth puerperal woman. Lynch considered the subject in detail in 1922.

A positive diagnosis can always be made upon vaginal examination, when the displaced uterus will be found to be larger and softer than normal—in other words, the condition is usually associated with subinvolution.

The restoration of the uterus to its normal position by bimanual manipulations, and the introduction of a properly fitting pessary during the third week of the puerperium, as a rule will afford prompt relief, and on removal of the pessary three or four months later it will frequently be found that a permanent cure has resulted. On the other hand, if the pessary is not applied until after the conclusion of the puerperium, much less favorable results are obtained, while if deferred until some months later its employment is usually useless. This fact serves again to emphasize the necessity for a careful examination before discharging the puerperal patient. Indeed, the experienced obstetrician should always make two examinations—one at the end of the second, or during the third week, and another one month later; as it often happens that the latter may reveal abnormal conditions, which had not become evident when the first one was made. When the patient has suffered from retroflexion before pregnancy, a pessary should be introduced on the tenth day of the puerperium, before the uterus has returned to its abnormal position. Better results are obtained in this way than if the uterus is allowed to undergo involution in a retroflexed position; but in either event the prospects of a permanent cure are questionable.

Relaxation of the Vaginal Outlet and Prolapse of the Uterus.—Reference has already been made to the frequent occurrence of perineal lacerations at the time of labor and the consequent relaxation of the vaginal outlet which follows neglect to repair them. Furthermore, it should always be remembered that pronounced relaxation sometimes follows overstretching or submucosal tearing of an inelastic or flabby pelvic floor in the absence of any visible laceration. In such circumstances, as there was nothing to repair at the time of delivery, the condition will escape detection unless an examination is made at the end of the puerperium.

Moreover, the changes following childbearing predispose to the occurrence of *prolapse of the uterus,* and an exacerbation should be expected during the puerperium in women who have presented moderate degrees of decensus uteri before labor. In order to obtain the best results, and to prevent serious disability, an early operation is advisable, since the difficulty of rectifying the condition depends largely upon the extent of the prolapse and the length of time that it has been allowed to exist.

Delayed Chloroform Poisoning.—Until very recently it was generally held that chloroform could be administered with impunity to the woman in labor. We now know that this is not the case, but that in rare instances symptoms of poisoning may set in several days after delivery and lead to death.

The investigation of Howland and Richards, and Whipple upon pregnant dogs shows that the process consists essentially in an autolysis of the hepatic cells, which may lead to almost total destruction of the secretory portion of the liver. In extreme instances the cells occupying the center of each lobule are completely destroyed, so that only a margin of approximately normal cells is preserved at the periphery. Associated with these changes is a pronounced perversion of metabolism.

I have encountered the complication upon several occasions, and the chemical findings in one of the fatal cases were described by Stander. Another occurred in a primiparous woman in whom forceps was applied on account of threatened fœtal asphyxia. The anesthetic was taken badly. The patient was in excellent condition for two days after delivery, but on the third day jaundice developed, and she passed into a torpid state, with occasional periods of excitement, and died in coma on the fifth day. At autopsy the liver presented an appearance similar to that observed in the early stages of acute yellow atrophy of the liver, and identical with that produced experimentally in dogs.

In the patient studied by Stander, there were an increased output of nitrogen, a marked decrease in the urea-nitrogen percentage and an increased ammonia coefficient in the urine; while the blood showed an increase in the nonprotein nitrogen and the amino-acids, and a definite decrease in the carbon dioxide combining power as well as in the sugar content. Such changes indicate an increased destruction, but incomplete ovidation of the proteins—a disturbance of the liver function, a moderate degree of renal insufficiency together with an acidosis.

No doubt such cases were occasionally observed in the past, when death was attributed to some obscure toxemia. In view of our present knowledge it behooves us to inquire whether we are justified in continuing to use chloroform as an anesthetic. Except in emergencies, I believe that it should no longer be employed in hospital practice, gas and oxygen being given in ordinary deliveries, and ether during all prolonged operative deliveries.

Obstetrical Paralyses.—Paralytic conditions may develop in either mother or child during the puerperium. That branches of the sacral plexus sometimes suffer from pressure during labor is demonstrated by the fact that many patients complain of intense neuralgia or of cramplike pains extending down one or both legs as soon as the head begins to descend into the pelvic canal. As a rule, the compression is rarely severe enough to give rise to grave lesions. In some instances, however, the pain continues after delivery, and is accompanied by the development of paralysis in the muscles supplied by the external popliteal nerve—the flexors of the ankles and the extensors of the toes—the gluteal muscles occasionally becoming affected to a lesser extent.

The subject has been carefully studied by Hünermann, H. M. Thomas, and Hösslin. The former supplied a very satisfactory explanation of the common localization of the paralysis by showing that the external popliteal nerve receives fibers from the fourth and fifth lumbar roots, and that these on their way downward to join the sacral plexus pass over the brim of the pelvis, where they are exposed to danger from compression, whereas the lower roots which lie upon the pyriformis muscle are more protected.

Hünermann considers that the chances of injurious pressure are greatest where the pelvis is generally contracted, in which event the nerves are compressed between the head of the child and the pelvic brim. Moreover, as only one oblique diameter of the superior strait is occupied by the greatest diameter of the head, it is readily understood why the paralysis is usually limited to one leg, Thomas's case being the only instance in which both legs were affected, which had been recorded up to 1900. The paralytic symptoms usually appear immediately after delivery, and may become permanent unless suitable therapeutic measures, more particularly the use of electricity, are promptly instituted.

In other cases paralytic symptoms, accompanied by intense neuralgic pains along the course of the sciatic nerve, follow pelvic inflammatory troubles. The condition is sometimes due to the development of a neuritis affecting certain branches of the sacral plexus, while in other cases pressure exerted by an inflammatory exudate is responsible. I have seen a case of the latter character, which had persisted for years in spite of continuous treatment, disappear as if by magic after laparotomy and the separation of the adherent appendages from the posterior and lateral portions of the pelvic wall.

Winschied has directed attention to the rare cases of *neuritis* which follow delivery. The condition may be general or localized. In the latter only one or two nerves are affected—the median, ulnar, or crural—while in the former, since a number of nerves are implicated simultaneously, sometimes even those of the face not escaping, the symptoms may be manifold and the condition become most serious. In either event we are ignorant concerning the mode of production of the nerve lesions, although when generalized they are supposed to be due to toxemic influences, being occasionally noted after toxemic vomiting and allied conditions. The prognosis is fair for the localized but poor for the generalized variety, although even the latter occasionally undergo spontaneous cure.

It is also important to bear in mind that separation of the symphysis pubis, or of one or other sacro-iliac synchondrosis during labor, may be followed by pain, and by so marked an interference with locomotion as at first sight to suggest the existence of paralysis. Moreover the disturbances in the function of the psoas muscles and the adductors of the thigh, which so frequently accompany the early stages of osteomalacia, might readily lead to a similar error.

In addition to these more localized processes the puerperal woman may occasionally suffer from paralysis of central origin. In most instances these result from various varieties of apoplexy, and occasionally from areas of cerebral degeneration incident to eclampsia and the other toxemias.

As a result of a difficult labor, and exceptionally after an easy one, the child is sometimes born presenting an affection of the arm which is commonly known as *Duchenne's,* or *Erb's paralysis.* In this form, paralysis of the deltoid, infraspinatus, and the flexor muscles of the forearm causes the entire arm to fall close to the side of the body, and at the same time to rotate inward, while the forearm becomes extended upon the arm. The motility of the fingers is usually retained.

Erb pointed out that such a paralysis could be due only to a lesion involving the fifth and sixth roots of the brachial plexus, and showed that electrical stimulation at a point from 2 to 3 centimeters above the clavicle and in front of the transverse process of the sixth cervical vertebra—now known as Erb's point—produces contractions of the muscles involved. He considered that the paralysis frequently follows compression of the plexus by the clavicle in the Prague method of extraction more particularly when the arms have become extended over the head, while in other cases it is due to traction with the fingers in the axilla of the child, and occasionally to the use of forceps. On the other hand, the experiments of Stolper show that the plexus cannot possibly be compressed by the tips of the forceps so long as the child presents by the vertex, although it may occur in face or brow presentations.

Carter, in 1893, was the first to direct attention to the fact that the condition is due to stretching or tearing of the upper roots of the brachial plexus more frequently than to abnormal pressure. His results were confirmed by the experimental work of Fieux, Schumaker, and Stolper, all of whom demonstrated that the plexus was readily subjected to extreme tension as a result of pulling obliquely upon the head, thus sharply flexing it toward one or other shoulder. As traction in this direction is frequently employed in order to effect delivery of the shoulders in normal vertex presentations, it is readily seen that Duchenne's paralysis may follow spontaneous labor, and thus be in no way due to violence on the part of the obstetrician. In view of these considerations, therefore, in extracting the shoulders care should be taken not to bring about too great lateral flexion of the neck. Moreover, in breech extractions the Prague maneuver should be employed only when absolutely necessary, and particular attention should be devoted to preventing the extension of the arms over the head, as it not only materially complicates delivery, but adds considerably to the danger of infantile paralysis.

The *prognosis* is usually fair, many of the children recovering. Occasionally, however, a case may resist all treatment and the arm may remain permanently paralyzed. All of the instances which I have personally observed ended in recovery, but in some of them prolonged treatment was necessary. In this form of paralysis the child should be promptly put under the care of a competent orthopedic surgeon, as the intelligent use of postural treatment will insure a useful arm, even if degenerative changes occur in the nerves and muscles.

In 1925, Ford considered in detail the paralyses which may follow cerebral injury at the time of labor, and in the following year Crothers and Putnam studied those following injuries to the spinal cord. The former pointed out that there is no evidence that Little's palsy, or diplegia, follows birth injury, and that while cerebral damage is a frequent cause of fœtal death within the first few days following delivery, it is only rarely concerned in such children as survive. Crothers and Putnam, on the other hand, showed very clearly that damage to the cord is a common cause of all sorts of infantile palsy, and is particularly prone to follow difficult breech extractions. In this country, their publication has served a very useful purpose, and has impressed upon obstetricians the necessity for not employing undue force in the delivery of children presenting by the breech.

Abnormalities and Diseases of the Breasts.—*Complete absence of both breasts* is one of the rarest anomalies of development, while the absence of one and the normal development of the other breast have been noted in a few isolated cases.

Hypertrophy of the breasts is more often observed, but abnormal enlargement is nevertheless an infrequent occurrence. In a large proportion of the recorded cases the condition developed rapidly in young unmarried women, both breasts being implicated and occasionally attaining such immense proportions that amputation became necessary. Cases have been reported in which a single breast weighed more than 50 pounds. The hypertrophy sometimes recedes during lactation, so that the abnormality does not always afford an absolute contra-indication to suckling the child. Overdevelopment of the mammæ is sometimes observed in men, a number of cases having been collected by Laurent.

Supernumerary Breasts.—Probably one in every few hundred women has one or more accessory breasts—*polymastia.* Reference to 262 such cases are to be found in Goldberger's article.

The supernumerary breasts are sometimes so minute as to be mistaken for small pigmented moles, and rarely attain any considerable size. They are often provided with distinct nipples, and are most commonly situated in pairs upon either side of the midline of the thoracic or abdominal walls, and usually below the main breasts; less frequently they are found in the axillæ, and occasionally upon other portions of the body—the shoulder, flank, or groin, and in rare instances the thigh. The number of supernumerary breasts varies greatly. When arranged symmetrically 2 or 4 are the commonest number, although Neugebauer has described a patient with ten.

The condition is usually regarded as an atavistic reversion, though it is not associated with an increased tendency toward multiple pregnancy. In not a few instances an apparent hereditary influence can be traced. Not all observers, however, accept this view, Ahlfeld holding that the distribution of the mammary tissue is to be attributed to the transference at an early period of development by means of the amnion of some of the cells, which ordinarily go to form the breasts, to other portions of the body. The condition has no obstetrical significance though occasionally the enlargement of supernumerary breasts occupying the axillæ may result in considerable discomfort. Quite frequently a tongue of mammary tissue may extend out into the axilla from the outer margin of a normal breast, while sometimes an isolated fragment will be found in the same location. Such structures undergo hypertrophy during pregnancy, and when lactation is being established become swollen and painful. Ordinarily, if let alone, they soon undergo regression and give no further trouble.

Abnormalities of the Nipples.—The typical nipple is cylindrical in shape and projects well beyond the general surface of the breast, its exterior being slightly nodular but free from fissures. Variations from the normal, however, are not uncommon, some of them being so pronounced as to interfere seriously with the act of suckling.

In some women the lactiferous ducts open directly into an area which forms a depression at the center of the areola. In pronounced instances of this so-called *depressed nipple* nursing is out of the question, although when the depression is not very deep the breast may occasionally be made available by the employment of an electrically driven breast pump.

More frequently, although not depressed, the nipple is so stunted that it hardly projects above the surface of the breast, and in consequence can be seized by the child's mouth only with the greatest difficulty. In the presence of this anomaly daily attempts should be made during the last few months of pregnancy to draw the nipple out by traction with the fingers. This, however, is rarely successful, so that, if the nipples cannot be made available by the temporary use of an electric breast pump, suckling will have to be discontinued.

Again, it sometimes happens that nipples which are normal in shape and size may present so fissured or nodular a surface as to be especially susceptible to injury from the child's mouth during the act of suckling. In such cases small cracks or *fissures* almost inevitably appear, and render nursing so painful that the mother dreads the approach of the child, and the mental distress so induced often has a deleterious influence upon the secretory function. Moreover, such lesions are still more serious in that they offer a convenient portal of entry for pyogenic bacteria which are liable to invade the breast and give rise to a mastitis. For these reasons every effort should be made to heal such fissures, and this is best effected by protecting them from further injury by the child by the use of a nipple shield, and by the use of soothing and antiseptic applications.

Abnormalities in the Mammary Secretion.—Marked individual variations exist in the amount of milk secreted, many of which are dependent not upon the general health and appearance of the individual, but upon the degree of development of the glandular portions of the breasts. Thus we often find that a woman who possesses large, well-formed breasts, and who apparently should be an excellent milk producer, secretes only a small quantity; while, on the other hand, one is often surprised at the abundant supply produced by another whose mammæ are small and flat. It is a matter of common observation that stout women with redundant breasts usually have a deficient secretion, the bulk of the organ being made up of fatty tissue while the glandular elements are poorly developed. Deficient secretion is likewise frequently noted in very young women and in elderly primiparæ. In the former the defect is to be attributed to imperfect development; in the latter to regressive and atrophic changes in the breasts.

In very rare instances there is an absolute lack of mammary secretion—*agalacia*. As a rule, however, the defect is not absolute, as it is nearly always possible to cause at least a small amount to exude from the nipple on the third or fourth day of the puerperium. On the other hand, relative deficiency is frequently observed, a large number of women secreting an amount of milk quite insufficient for the nutrition of the child. In Chapter XVII reference was made to the variations in the quantity of the milk as well as the various factors which may be concerned in their production.

Occasionally the mammary secretion is excessive—*polygalacia*—and may even be so abundant that milk is constantly escaping from the nipples. This latter condition, which is known as *galactorrhea,* sometimes continues for years after the birth of the child, and is extremely intractable to treatment. Nothing is known as to its cause. Although in rare instances the health of the woman may remain unimpaired, as a rule she soon begins to show evidences of the continuous drain upon her system, becoming irritable, querulous, and eventually developing symptoms of cachexia.

Galactorrhea is best treated by not attempting to empty the breast, but by allowing it to become engorged, in the hope that the intramammary pressure will become so great as to compress the vessels and thus check secretion. At the same time the breasts should be supported by a bandage, and fairly large doses of potassium iodide should be administered. Good effects are also said to have been obtained from the use of chloral. In a certain number of cases the condition is combined with atrophy of the uterus, and several observers have reported improvement following procedures which tend to bring about an increase in size of the uterus, such as the use of the vaginal douche, local applications to the cervix, or the employment of electricity.

Diseases of the Nipples.—The mode of production and treatment of fissures of the nipples has already been considered in detail in Chapter XVII.

Engorgement of the Breasts.—For the first twenty-four or forty-eight hours following the development of the lacteal secretion, it is not unusual for the breasts to become immensely distended, and to offer on palpation a firm, nodular resistance. This condition, which is commonly known as *"caked breast,"* often gives rise to a considerable degree of pain, and is sometimes accompanied by a slight elevation of temperature. Within a day or so the engorgement usually passes off spontaneously, or as the result of appropriate treatment, though in some cases it persists in spite of all that can be done, and may be a forerunner of the development of a mammary abscess. It is probable that the excessive distention of the glandular portion of the breast leads to slight tissue changes, thereby offering a *locus minoris resistentiæ* to invasion by bacteria, which are usually present in the lactiferous ducts.

Whenever the breast becomes markedly engorged immediate steps should be taken to relieve the condition. This is most readily accomplished by drawing the breasts firmly against the thorax by means of a tight binder, applying an ice bag, and if necessary giving ¼ grain of codeia, which may be repeated in three hours if necessary. Usually this will relieve the condition within twenty-four hours, and the physician is cautioned not to be too hasty in resorting to other measures.

If the engorgement does not show signs of subsiding within this period, and particularly when the child is unable to draw off a sufficient quantity of milk, an English breast pump, or better still, an electrically driven pump, should be employed to remove the excess. If this proves ineffectual many authorities advocate attempting to empty the breasts by massage, although I have not employed it for many years. In my experience, supporting the breasts by a suitable bandage, the use of an ice-bag, and the very occasional administration of a sedative is all that is required, and I have gained the impression that the use of energetic measures often defeats the very purpose for which they are employed, as they stimulate rather than diminish the secretory activity of the breasts.

Drying up the Breasts.—After the death of the child, or in cases in which for one reason or another the continuance of lactation is thought inadvisable, steps must be taken for checking the lacteal secretion, or "drying up the milk," as it is usually designated. Formerly this was accomplished by the use of the binder, the application of belladonna ointment, and the employment of the breast pump and massage when the engorgement became pronounced. The process was frequently very painful to the patient, very troublesome to the nurse, and usually had to be employed for a week or ten days or even longer before the desired result was obtained.

In 1904, E. R. Lewis, of Westerly, R. I., told me that much more satisfactory results could be obtained by the administration of 20 grains of potassium acetate every six hours. I immediately put his suggestion into practice, and found that the breasts dried up in the course of two to four days without other treatment. Further investigations, however, showed that the potassium acetate was of no value, as equally satisfactory results followed if drugs were not used.

Accordingly, when it is desired to "dry up" the breasts, they are left absolutely alone. In the course of twenty-four hours they become more or less engorged, and sometimes very painful. If the pain is severe, ¼ grain of codeia is administered, and repeated if necessary, but the breast pump or massage is not employed. Within a few hours the engorgement so compresses the vessels within the breasts that the secretory activity is checked after which the engorgement subsides, and the pain diminishes, and within twenty-four or thirty-six hours the breasts become soft and painless. With each succeeding day the secretion becomes less and less abundant, and practically disappears in the course of a week.

H. J. Storrs, in 1909, published a report of the cases so treated in our clinic, and stated that not a single breast abscess had developed during the period of observation, and that less than one woman in ten had complained of sufficient pain to necessitate the administration of a sedative. I have employed this method exclusively since 1905, and since then I have had no occasion to employ belladonna ointment, the breast pump, massage, or the tight breast binder. Ice bags, however, are used, and when the breasts are large and pendulous they are supported by means of a binder, which does not exert pressure upon them.

Inflammation of the Breasts—Mastitis.—Parenchymatous inflammation of the mammary glands is a rare complication of pregnancy, but is frequently observed during the puerperium and lactational period. I see several examples of the former complication each year, and Whitcher, in 1914, showed that it did not differ from the puerperal type except in the time of its appearance. The symptoms of mastitis rarely appear before the end of the first week of the puerperium, and as a rule not until considerably later. Marked engorgement usually precedes the inflammatory trouble, the first sign of which is afforded by chilly sensations or an actual rigor, which is soon followed by a considerable rise in temperature and an increase in the rate of the pulse. The breast becomes hard, its surface is reddened, and the patient complains of acute pain. In many instances, by the end of twenty-four hours the condition disappears spontaneously without treatment, being often favorably influenced by the application of cold and of a tightly fitting bandage. But if the symptoms persist for longer than forty-eight hours, suppuration is to be expected. The process may remain limited to a single lobe if the abscess is opened promptly; but if left to itself the breast is liable to become undermined in all directions, and, as a result, the destruction of tissue is extensive, and the external surface may be left riddled with numerous fistulous tracts.

In some cases the constitutional symptoms attending a mammary abscess are very pronounced, and very exceptionally lead to a fatal termination. On the other hand, the local manifestations may be so slight as to escape observation. Such cases are usually mistaken for puerperal infection, and give rise to no little anxiety until the examination of cultures from the uterine cavity has demonstrated the absence of bacteria. In still another group of patients the process pursues a subacute or almost chronic course, the breast being somewhat harder than usual and more or less painful, but constitutional symptoms are either lacking or very slight. Under such circumstances the first indication of the true state of affairs is often afforded by the detection of fluctuation.

Etiology.—Mastitis is always the result of infection, pathogenic bacteria from outside gaining access to the breast through fissured nipples by way of the lymphatics; or else some of those already present in the lactiferous ducts meet with conditions which enable them to invade the tissues. The researches of Bumm, Hönigmann, Koestlin, and others have demonstrated that Staphylococcus albus is present in 80 to 94 per cent of all breasts. Ordinarily this micro-organism lives in the milk as a harmless parasite, but when the tissues are seriously altered as the result of engorgement, it is possible for it to become pathogenic. Rubeska reported the following bacteriological findings in 16 cases of mammary abscess:

	Cases
Staphylococcus aureus	9
Staphylococcus aureus and albus	3
Staphylococcus albus	3
Streptococcus	1

Exceptionally, other bacteria are causative agents, Sarfert having demonstrated the gonococcus, Chassot the Bacillus pyocyaneus, and Little the gas bacillus.

When the infection occurs through fissured nipples the inflammation is usually phlegmonous in character. In some cases it involves only the connective tissue beneath the breast, a large collection of pus being formed between it and the thoracic wall—retromammary abscess. Again, the infection may be limited to the areola, beneath which small abscesses, rarely exceeding 1.5 centimeters in diameter, may develop—*subareolar mastitis*. In rare instances the affection may be erysipelatous in character, and be limited to the superficial tissues.

According to Winckel, two-thirds of all cases of mastitis occur in primiparæ, but its actual incidence varies according to the care given during pregnancy and the puerperium. Thus, the statistics of Rubeska showed a frequency of 0.54 to 4.1 per cent in the various German clinics. Generally speaking, it may be said that the frequent occurrence of mastitis is indicative of neglect on the part of the physician or nurse.

Treatment.—The occurrence of mastitis can be prevented in great part by suitable prophylactic measures, which mainly consist in preventing the development of fissured nipples or treating them properly after they have appeared.

The most suitable measures for treating the nipples during pregnancy, so as to enable them to better withstand the strain of nursing, have already been mentioned in Chapter XVII. When the lactation becomes established the strictest cleanliness should be observed and the nipples watched carefully. As soon as a fissure begins to develop a nipple shield should be employed, the child not being allowed to apply the mouth directly to the nipple until healing has taken place. In the intervals between the feedings the sore nipple should be covered with a piece of absorbent cotton soaked in a saturated solution of boric acid. Various applications are recommended, but however good in themselves, they will prove practically valueless, unless the nipple can be placed at comparative rest, which is best effected by the use of a suitable nipple shield. If the condition becomes worse after some days' trial of this treatment it is advisable to wean the child rather than take the risk of infection, which is so prone to follow if the deeply fissured nipple be used for any length of time.

On the first symptom of mammary infection the breast should be put at rest as far as possible by not allowing the child to suckle, and withdrawing the milk, if necessary, by means of a breast pump. After being emptied the breast should be thickly covered with cotton, and by means of a tightly fitting bandage subjected to the greatest possible pressure consistent with the comfort of the patient, and an ice-bag applied. In many cases such treatment apparently cuts short the process, the symptoms disappearing within twenty-four hours, after which the patient may resume suckling her child. Usually, however, the process sooner or later eventuates in abscess formation.

As Bier's method of artificial hyperemia has not been successful in my hands, it is my practice to incise the breast as soon as definite evidence of fluctuation can be obtained. Procrastination is not permissible, delay being synonymous with extension of the process, which frequently leads to such extensive destruction of the tissue as to destroy permanently the physiological function of the organ. The incisions should be made radially, extending from near the areolar margin toward the periphery of the gland, in order to avoid injury to the lactiferous ducts. In early cases a single incision over the most dependent portion of the area of fluctuation is usually sufficient, but when multiple abscesses are present several incisions may be required. The operation should always be done under anesthesia, and should not be considered as completed until the obstetrician has introduced a finger through the incision and carefully explored the interior of the breast, breaking down the partition walls between the various pockets of pus, so that only a single abscess cavity is left to be dealt with. This should then be loosely packed with gauze and replaced at the end of twenty-four hours by a smaller pack. If the pus has been thoroughly evacuated, the abscess cavity becomes obliterated with a rapidity which is sometimes surprising.

Galactocele.—Very exceptionally, as the result of the clogging of a milk duct by inspissated secretion, an accumulation of milk may take place in one or more lobes of the breast. Ordinarily this is limited in amount, but may become excessive and form a fluctuant tumor which may give rise to pressure symptoms. In many instances massage and the application of a tight bandage will cause it to disappear, and I have never seen the structure attain such size that puncture was necessary.

Puerperal Psychoses.—Reference has already been made to the alterations in the mental condition which may accompany pregnancy. These vary from slight changes in disposition to actual insanity, though fortunately the latter is of relatively rare occurrence.

In the absence of the usual etiological factors or a hereditary taint, the insanity of pregnancy is usually a manifestation of auto-intoxication, and may be accompanied by melancholic or maniacal symptoms. It usually persists throughout the remainder of gestation, but disappears shortly after labor.

Puerperal insanity, on the other hand, is more common, and according to the statistics compiled by Berkley and Jones is noted once in every 616 and 1100 labors, respectively. In former times it was a comparatively common complication, and it would seem that the introduction of aseptic methods into obstetrics is responsible for a reduction by one-half in its incidence. The affection usually makes its appearance within the first two weeks following delivery. When it occurs later it is designated as *lactational insanity.*

Following Olshausen's contribution in 1891, it has been generally recognized that the causative factors concerned in production of puerperal psychoses fall into three great groups—infectious, idiopathic, and toxemic. In the past, the former was the most important, but with gradual improvement in aseptic technic it has lost a great part of its significance, although I have repeatedly seen puerperal insanity associated with infection, due to the streptococcus alone or in combination with the colon bacillus.

At present the idiopathic type is the most usual, and it commonly occurs in women with hereditary tendencies or in those who are unable to accommodate themselves to the complications of married life. The toxemic type is best represented by the outbreaks of insanity which sometimes occur a day or so after the cessation of an eclamptic attack. Olshausen noted it in about 6 per cent of his eclamptic patients, and I see a case or so each year.

The idiopathic psychoses do not differ from those occurring at other times, and may occur in various forms and with varying degrees of intensity. The infectious types are usually characterized by great excitement during the first few days, associated with all sorts of hallucinations. Later the maniacal symptoms disappear, and the patient passes into a condition of depression, and frequently exhibits suicidal tendencies. The posteclamptics are sometimes very violent, and the delusions often have a religious tinge, while in other cases the color sense is greatly affected.

The prognosis is most favorable in the cases following eclampsia, the majority of such patients recovering within a few weeks. On the other hand, those following infection are very tedious, and 20 to 40 per cent of the women fail to regain their mental equilibrium. It is not unusual for the disturbance to last for from three to six months, although the prospect for recovery is poor if the latter period is exceeded.

In the idiopathic type the prognosis varies according to the underlying cause, and according to Saunders only about one-half of the patients recover permanently. It was formerly stated that from 5 to 10 per cent of the patients suffering from the various types of puerperal insanity died, but with the present lessened mortality from puerperal infection and eclampsia such figures give an exaggerated idea of the danger.

In cases following infection the treatment should first be directed to the underlying condition, and the directions described in Chapter XLIII rigorously followed. The acute maniacal symptoms should be met by the administration of sedatives, and the patient should be watched most carefully throughout her entire illness, more particularly during the periods of depression, during which she should never be left alone for fear that she may do an injury to herself. If prompt improvement does not follow the disappearance of the symptoms ascribable to infection, the patient should be placed in charge of a competent psychiatrist.

Typhoid Fever.—Formerly, this was not a rare complication of the puerperium, but with the increased attention paid to the supply of milk and water, it has become very uncommon. Its course, however, varies but little from that observed under other conditions, although the prognosis is necessarily somewhat influenced by the fact that the patient is already debilitated by the strain incident to labor. The diagnosis should never be made unless a positive Widal reaction can be demonstrated, inasmuch as all the other symptoms of the disease may be associated with a prolonged puerperal infection, especially when the endocardium is involved. Furthermore, the so-called typhoid condition is often encountered in various forms of pyemia.

Malarial Fever.—In certain districts the puerperium is sometimes complicated by malarial infection. Although the course of the disease is not materially influenced by the fact that the patient has recently given birth to a child, it is interesting to note that labor, no less than surgical procedures, seems to predispose to a recrudescence of the disorder in women who have already suffered from it, the typical phenomena often appearing during the first few days of the puerperium.

Too many sins of omission and commission on the part of the obstetrician have undoubtedly been cloaked under the diagnosis of "malaria." At the present day, whenever a puerperal patient presents a temperature characterized by marked remissions and possibly by chills, puerperal infection should be suspected, and the existence of malarial fever should not be entertained until all other possibilities have been practically eliminated and the characteristic parasites have been found in the blood.

As soon as a positive diagnosis has been made, quinin should be given in sufficiently large doses to break up the attack, as the drug exerts no appreciable influence upon the mammary secretion or the well-being of the child.

Pneumonia.—Croupous pneumonia is a rare complication of the puerperal state, unless the disease has existed before the onset of labor. The outlook is always serious.

The lobular variety, or bronchopneumonia, is often a terminal process, and is one of the most common causes of death in patients who succumb within a few days following an eclamptic attack. The treatment does not differ essentially from that employed at other times.

Scarlet Fever.—Although scarlet fever is rarely encountered during the puerperium, its occurrence has given rise to a great deal of discussion and a very considerable literature. The interest manifested in the disease is largely to be accounted for by the fact that a scarlatiniform rash is occasionally observed during the course of a puerperal infection so that in many cases a differential diagnosis becomes very difficult.

The classic articles upon scarlet fever in the puerperium were by Braxton Hicks, and Olshausen, while the subject was brought up to date by Poesch, in 1926. While epidemics have been reported by various writers, it appears probable that the puerperal woman is to a certain extent immune from the disease, inasmuch as statistics go to show that only a small proportion of those exposed to the contagion become infected.

It is generally stated that infection may occur in the usual manner, as well as by the entrance of the specific poison through wounds about the genitalia. The belief in the possibility of the latter eventuality is based upon the fact that the rash occasionally appears first in the neighborhood of the vulva, and thence spreads to other portions of the body. Moreover, the frequent association of pelvic inflammatory troubles, and the occasional localization of diphtheritic patches in the vulva or vagina, instead of in the throat, are advanced in support of the view. Modern bacteriological investigation, however, has destroyed the force of this last argument, since it has shown that a specific hemolytic streptococcus is probably concerned in the causation of scarlet fever, and thereby makes it more difficult to distinguish symptoms due to frank puerperal infection and those due to scarlet fever. At the same time it is generally admitted that true scarlet fever may occur, and it is urged that the appearance of the disease on the third or fourth day of the puerperium speaks in favor of transmission of contagion through the genitalia.

In frank cases the diagnosis is readily made from the existence of a characteristic rash, which is later followed by desquamation. Moreover, the strawberry tongue, the development of pseudodiphtheritic patches in the pharynx, the appearance of albumin in the urine, together with a history of exposure to possible contagion, usually remove all doubt. On the other hand, in the absence of characteristic manifestations, a differential diagnosis cannot be made, even when a distinct history of exposure to contagion can be elicited.

The prognosis is largely the same as under other circumstances, mild forms, as a rule, ending in recovery, whereas patients affected with the hemorrhagic variety usually die. The puerperium appears to exert little effect upon the course of the disease, the death rate not being higher than under ordinary conditions. The child may or may not be infected.

Measles and **smallpox** occasionally occur during the puerperium, but their course does not differ materially from that observed in women who have not recently given birth to children.

Diphtheria.—True diphtheritic patches, in which the Klebs-Löffler bacillus can be demonstrated, occasionally occur upon denuded portions of the vulva and vagina. They may be due to a primary genital infection, or be merely part of a process primarily localized in the throat. Such lesions, however, should be more frequently observed if the observations of Wauschkuhn are correct. He stated that the vaginal secretion frequently harbors diphtheria bacilli; which he was able to isolate in eleven instances in a series of 200 women. Inasmuch as pseudodiphtheritic patches in the genital tract are of frequent occurrence during the course of puerperal infection, the presence of fibrinous exudates about the vagina or vulva should lead to a diagnosis of diphtheria only when the characteristic bacilli can be demonstrated. If the process is limited to the genital tract, the constitutional symptoms are not severe, and the disease usually pursues a benign course, readily yielding to the employment of antidiphtheritic serum.

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